AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 16, NO. 42. WEEKLY. | NEW YORK, THURSDAY, OCTOBER 19, 1893. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

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On the Cultivation of the Inventive Capacity by the Solution of Constructive Problems.

BY LEICESTER ALLEN.

Figs. 1 and 2 are attempted solutions to Problem No. 5, forwarded by Mr. M. Jacker, Jr., of Chicago, but he is not responsible for them. He sends in some solutions of his own, which will be considered in the present article. Those illustrated by Figs. 1 and 2 are given as samples of many which have been received in response to Problem No. 5, with a view to impress upon my readers the fact that it is not wise to be hasty in concluding that a solution fills all the conditions. Mr. Jacker writes with reference to his own solutions and those shown in Figs. 1 and 2, as follows:

"The AMERICAN MACHINIST has become twice as interesting to me since the addition of these problems as it was previously. They are solid food for the inventor as well as palatable and nutritious for amateurs. I inclose you eight solutions to Problem No. 5, six of which are my own; the other two are ten-minute ideas of a mechanical engineer, or rather both of them were sketched inside of ten minutes after he was acquainted with the problem; but he would not bother with sending them in, so I take the pleasure of doing so for him, as he is an inhabitant of my town."

Neither of these ten-minute solutions meets the requirements of the problem as enunciated. In the first, Fig. 1, either of the disks *A* or *B* may be the driver. Upon their perimeters is fitted a friction ring or wheel *C* which revolves about the center *D*. When either *A* or *B* is rotated in either direction, the friction ring *C* and the other disk will be rotated in the same direction. This makes both *A* and *B* friction wheels, a device which was expressly excluded in the third restriction accompanying the problem as published in the issue of April 13th.

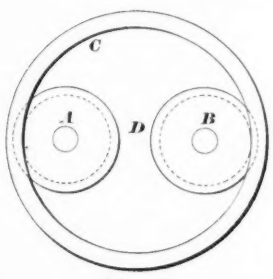
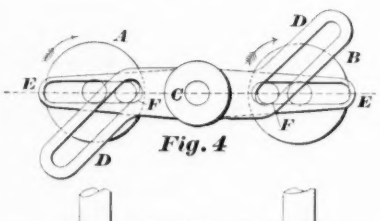


Fig. 1



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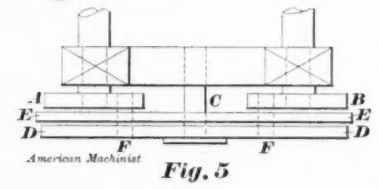


Fig. 5

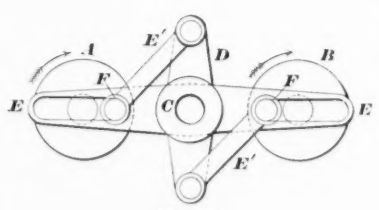


Fig. 6

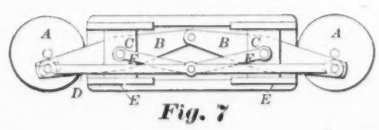


Fig. 7

In Fig. 2, *A* is the driver and *B* is the driven wheel, but either of these may be used as a driver when desired. The defect in the solution is the same, no matter which disk is the driver. *C* and *D* are the crank-pins. The crank-pins are connected by a Y-shaped connecting rod *E*, to the lower end of which is pivoted a slide working on guides *G*. Now let us suppose an attempt to be made to bring the crank-pin *C* to the position *C'*. The connecting rod *E* being rigid, the arc *C F D* or the distance from *C* to *D* must remain constant in any position of the crank pin *C*. Also the distances from the center of the slide-pin to the centers of the crank-pins respectively, as indicated by dotted outlines, must be equal and constant for any crank position. The distance *C H* being laid off from *C'* to the medial line *F F' F''*, the center of the slide-pin must be at *H'* when the center of the crank-pin *C* takes the position *C'*. The arc *C' F' D'*, described with the radius *H' C'*, is equal to the arc *C F D* described with the equal radius *H C*. The position which the center of the crank-pin *D* must take in order that the center of the crank-pin *C* may take the position *C'*, will be found by taking the distance *C D*, and with *C'* as center describing the short arc *a b*, and then with radius *H' D'* and center *H'* describing the arc *C' F' D'* intersecting the arc *a b*; the point of intersection *D'* is the position sought. But this is clearly seen to be impossible, as the point *D'* lies outside of the crank circle described around the center of the disk *B*. It is thus seen that the device will be inoperative, and that it can only be made operative by attaching the guides *G* to a support arranged to slide horizontally a distance equal to the diameter of the crank-pin circle.

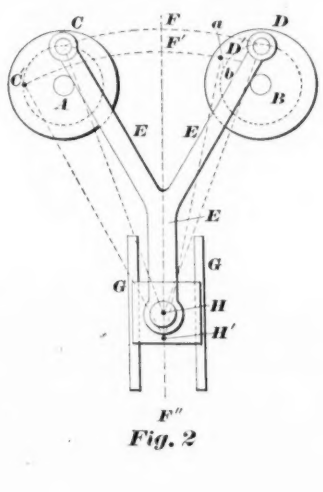


Fig. 2

The first of the six solutions contributed by Mr. Jacker is shown in Fig. 3. Instead of disks, Mr. Jacker uses two reels, *A* and *B*, with rollers *a* pivoted to the ends of the reel arms. These rollers press against a flexible and collapsible tube *C*, this tube being fastened to stationary circular supports *D*, and having its extremities extending down into a tank *E* containing liquid. When reel *A* rotates in the direction indicated by the arrow, the rollers in the reel arms pressing against the tube *C* and collapsing it, will, if the tube be filled with liquid before starting, cause the liquid to move as indicated by arrows, and to circulate through the tube *C*, continually drawing the liquid out of the tank and returning it again into the tank. But in order that the circulation shall take place as described, the reel *B*, which keeps the tube *C* collapsed, must move also in the same direction as *A* moves.

If the tube could be perfectly collapsed so as to prevent any leakage by the collapsed parts in either direction, this movement would fulfill the requirements of the problem fairly well. Either of the reels may be used as a driver. I remember seeing a water-meter constructed on this principle with a single reel, which was exhibited at the Croton Pipe-Yard in New York City, in the autumn of 1867. The reel was driven by a stream of water flowing through a rubber tube, and the register was driven by the axle of the reel. Although this device was pretty well made, there was some slip of the water past the collapsing rollers. I therefore think that it would be difficult to adjust the reels and the tube in such manner as to insure that the driven wheel would move at the same velocity as the driver The movement is a curious one, however, and so unique that I think it will interest many readers.

The second and third solutions sent in by Mr. Jacker are substantially the same as those contributed by Mr. C. E Sargent, presented in my last article. The fourth solution is of the flexible shaft variety. The fifth and sixth solutions contributed by Mr. Jacker are accompanied by sketches of so crude a character that I could not impose upon myself the task of reproducing them in a form suitable for publication.

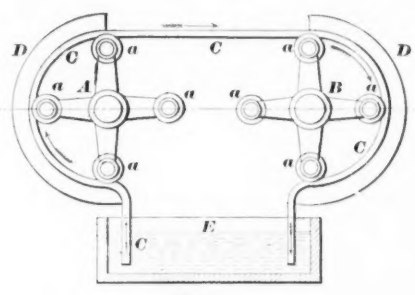


Fig. 3

In Figs. 4, 5 and 6 is shown a solution contributed by Mr. W. T. Sears, of Plymouth, Mass. *A* is the driver, and *B* the driven wheel; but either may be the driver. Figs. 4 and 5 show one form of the device, and Fig. 6 shows another form. The crank-pins are shown at *F*, and upon them are fitted two slotted bars, as shown in Figs. 4 and 5 in side elevation and plan; or in the modification, Fig. 6, the rock-bar *D* is substituted for the slotted bar *D*, and is connected to the crank-pins by links *E'*. The bars *D* and *E* are centrally pivoted to a fixed support at *C*. The crank-pins should be supplied with friction rollers. This device will work in strict accordance with the requirements of the problem, and is a good movement for light work.

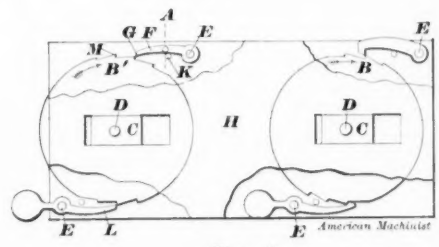


Fig. 8

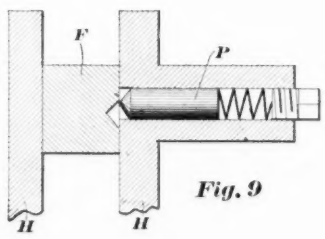


Fig. 9

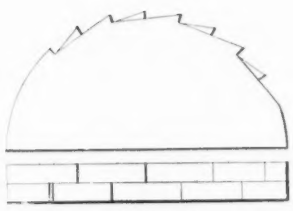


Fig. 10

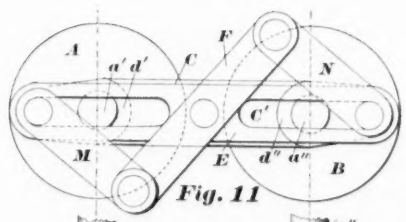


Fig. 11

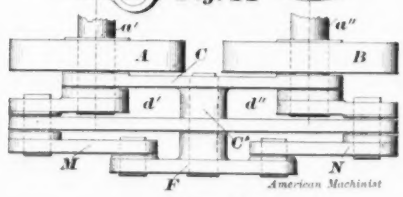


Fig. 12

Mr. Sears has sent in three other solutions, one of which is substantially identical with that of Mr. Francis W. Clough, of Springfield, Mass., presented in my article in the issue of July 20th; another is like that of Mr. W. Croker, of Orillia, Ont., and the third is of the pantograph variety.

Mr. J. T. Slocomb, of Providence, R. I., has contributed the solution shown in Fig. 7. In this device either wheel *A A* may be the driver; *B B* are rock-bars adapted to rock in the crossheads *C C*. *E E* are guides attached to the frame of the machine. *D* is a plain connecting rod. *F F* are short links connecting the crossheads with the center of the connecting rod. The crank ends of the rock-bars *B B* are slotted, and the crank-pins work in these slots. This movement fulfills all the requirements.

A second solution forwarded by Mr. Slocomb is shown in Figs. 8, 9 and 10. Fig. 8 is a side view of the wheels with their connections, and Fig. 9 is an enlarged sectional detail, the section being made on the line *A* in Fig. 8. Fig. 10 is a partial side elevation and plan of a modified form of ratchet wheel which may be substituted for the single ratchets shown in Fig. 8. "The two wheels *B B* are ratchets, only a few teeth being shown. Two pairs of blocks *C C* are loosely mounted upon the shafts *D D*, one on each side of each wheel *H* is one of two flat plates, a partial section of each being shown in Fig. 9. The ratchet wheels are between these two plates. The plates are rigidly connected with each other by studs *E*, which studs also form pivots for the pawls; and the plates are arranged to slide upon the blocks *C*, as shown in Fig. 1. As-

suming the ratchet wheel B to be the driver, the device operates as follows:

"The pawl F is prevented from going further down by the pin K, when in the position shown, and the point of the pawl must slip off the point of the tooth G. At the same time the point of the pawl L, on the lower side, is just engaging, this engagement drawing the two side plates and pawl F back into position for a new hold. As the slide H moves back at the same speed that the teeth advance, the point of the pawl F will meet the tooth M just one-half its length back, unless there is something to prevent. The object of the arrangement shown in Fig. 9 is to make the pawl skip the tooth M and engage with the next one when it comes directly over the center. This can be done by making the pawl when it slips off from a tooth rise sufficiently to clear any tooth that is a little off from the center. In Fig. 9 is shown a section of the pawl with a conical cavity to fit the plunger P, which plunger is kept out by a spring behind it, as shown. This plunger governs the pawl. The lower pawl of course must have the same attachment. It will be seen that the motion of the wheel B in the direction of the arrow will give the plates H H a reciprocating motion, and then the double pawls on the driven ends will cause the wheel B to rotate in the same direction."

Mr. Slocomb writes further, that if the driving ratchet be made in two parts, as shown in Fig. 10, with the upper pawl fitted to work into one part while the lower pawl works in the other, the spring-pin, shown in Fig. 9, would not be needed and a better movement would be the result. He thinks that this might be a useful movement in some cases where a quick reciprocating movement is wanted from a slowly revolving wheel, and where only a small amount of gearing could be used. I think, however, that such a movement could be obtained by a much simpler method.

A solution sent in by Mr. Wendell P. Tarbell, and shown in Figs. 11 and 12, has considerable analogy to that of Mr. Sears, shown in Fig. 6. Mr. Tarbell's solution, however, requires no external support other than the shafts of the driving and driven wheels. With reference to this solution and to these problems in general, Mr. Tarbell writes as follows:

"This problem department of Mr. Allen's is one of the best features of the paper, to my mind, and if the articles could appear more frequently and at regular intervals, they would be still more interesting to follow. The inclosed sketches and description will show my device clearly.

"In the drawings, A and B are the disks held on shafts a' a''. C is a bar fitted to be supported on the shafts a' a'' and next to the disks A B. The crank arms d and d'' are fitted and fastened to the shafts a' a'', just outside of the bar C. Projecting from d' d'' are crank pins having equal radii. Freely supported on these crank-pins is the slotted connecting bar E. From the bar C at a point central between the shafts a' and a'', and in line with them, projects the stud C'. The connecting bar E is supported on this stud at a central point. F is a bar pivotally hung on the stud.

"M and N are links pivoted to the cranks a' a'' at one end, the other to opposite ends of the bar F at points equally distant from stud c'. It is now understood that the bar C is supported in a fixed position, that the shafts a' a'' are free to turn within it; that C is merely a support for the stud C', which in turn supports the vibrating bars E and F.

"This provides a transmitting device supported alone by the two shafts, and in accord with the requirements of the problem. It allows either shaft to be taken for the driver, and to be rotated in either direction."

I had hoped to be able to complete the consideration of Problem No. 5 in this article, but this has proved impossible without demanding more space than could be afforded. In my next article I will be able to conclude the solutions received, and to announce another problem.

Theory of Steam Engine Governors—I.

BY J. BEGTRUP.

Although the governor is a very essential part of the steam engine there has not yet appeared a complete theory to satisfy all the questions which may be asked in reference to its action and efficiency, and a great deal is consequently left to guesswork and experimenting. The now existing theories have reference only to the conditions of equilibrium, while the dynamic principles involved have not been investigated. In other words the *action* of the governor is not generally understood, and as the problems arising in this connection are rather perplexing it is not to be wondered at that so many erroneous opinions have prevailed.

The present state of perfection in governors is wholly the work of experimenters; here, as usual, invention goes before theory. The correct theory may indeed have been formed in the mind of the inventor, but such does not become public property before some instructor interests himself in it and puts it in print.

The complete theory of governors is rather difficult to master, but it cannot be denied that it will be of value to engineers and designers, for it does away with all experimenting as it enables us to foretell the results. The theory worked out by me is the result of study and observation covering a number of years, and I believe it to be essentially new yet complete. It is not my intention here to present anything but that which is of practical value, and I shall use no other arguments than the fundamental laws of matter and motion. The following is a synopsis of what I propose to show:

That the movements of the governor weights are essentially oscillations.

That governors operated by centrifugal force and gravity are not so sensitive and more liable to "race" than governors having springs to oppose the centrifugal force.

That the only real advantage of the high-speed loaded governor is a smaller twisting strain on the hinges.

That where heavy parts are to be moved by the action of the governor weights these must be heavy or else powerful springs must be used to overcome the inertia of the parts, otherwise the governer will be apt to race.

That the arms of a Watt's governor should form a right angle between them rather than an acute angle.

That some friction is necessary for the stability of any governor.

That a small amount of sticking or friction of rest will make close regulation impossible.

That a dash pot will prevent violent racing, but the only remedy for smaller oscillations, if not due to friction, is to change the governor or increase the weight or size of fly-wheel.

That stability of a Watt's governor is increased by increasing the rise of the balls, but this will also cause a greater variation of speed.

That in general the greater the variation of speed for different conditions of load and steam pressure, the greater will the stability of the governor be.

That perfect isochronism is impossible in an ordinary centrifugal governor, that is, it must make a greater number of revolutions per second when the engine is running light than when it is loaded.

That an increase of weight and diameter of the fly-wheel will effect greater stability in the centrifugal governor, and also to some extent limit instantaneous variations in speed.

That size and weight of fly-wheel may vary greatly with different governors.

That an automatic cut-off engine governor requires a heavier fly-wheel than a throttling governor.

That with a pair of automatic cut-off engines having cranks at right angles, a lighter or smaller wheel may be used than on a single crank engine of the same power.

That weight and size of fly-wheel is of little consequence in connection with an "inertia governor."

That an inertia governor can be made perfectly isochronous.

That reciprocating parts have but small effect on governors.

The effect of unbalanced parts.

The principle of the "dynamometrical" governor.

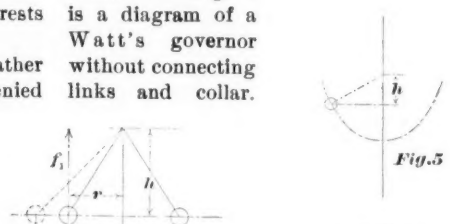
Mr. Ball's invention.

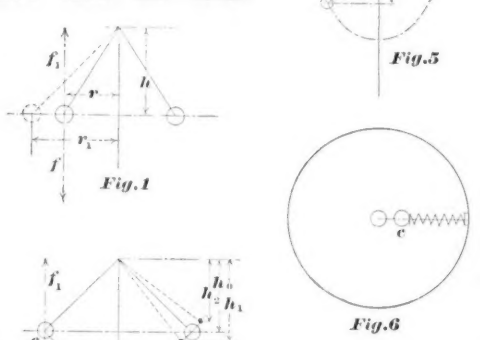
Some fallacious theories.

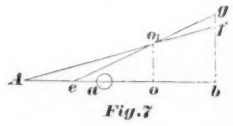
The writer's personal experience, etc.

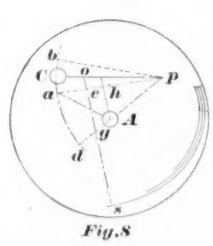
I shall also give general formulas by which the dimensions, weights, proportions, and weight of fly-wheel for any governor may be correctly calculated.

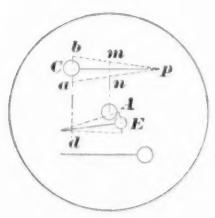
As an introduction leading up to my subject, I shall first give a short account of the first principles of the ordinary centrifugal governor as found in text-books, with some additions. Fig. 1 is a diagram of a Watt's governor without connecting links and collar.

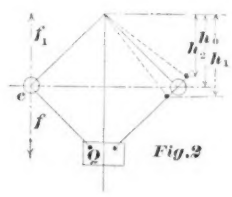


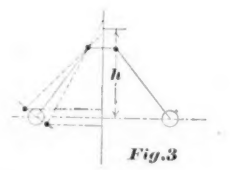


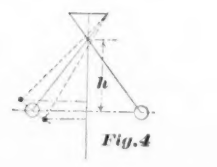


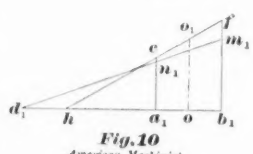












The centrifugal force is resolved into two forces—one along the arm and one perpendicularly upwards denoted by f_1. The weight of the ball acts perpendicularly down, and is denoted by f. When the two forces f and f_1 are equal, the ball will not move in any direction; it is in equilibrium. This will be the case when the governor is making a certain number of revolutions per second, say n revolutions. If we increase the weight of the ball, the centrifugal force is increased in the same proportion, the condition of equilibrium is not changed and the speed remains the same.

Let the triangle formed by one arm and the spindle represent the "triangle of forces," r representing centrifugal force and h its vertical component; then for another position of the ball in the same horizontal plan, as shown in dotted line, r_1 will represent centrifugal force, for this force is proportional to the distance from center of rotation; the triangle of forces is now changed, but h is still its vertical component, which shows that if the ball is in equilibrium at a speed n it will remain so for any position on the line r or its continuation, or in other words, as long as the height h remains the same the speed of the governor will not be changed; that is, for any given height h there must be a certain speed at which the weight of the balls will be balanced by centrifugal force. The distance h is sometimes called the height of the cone, because the arms describe a cone when revolving.

Fig. 2 is a diagram of a governor having a central weight Q suspended from the balls. Suppose this weight moves two inches while the balls move one inch vertically, then there will be a downward pull on each ball $= c + Q$, where c = weight of one ball, that is, $f = c + Q$. The governor must, of course, make a greater number of revolutions per second to keep this weight suspended than when there is only the weight of the balls to support. As there is nearly always some unbalanced weight on the collar of a governor, the case here considered is in fact the general case It is evident that here, as in the former case, the speed depends on the height h.

The centrifugal force of one ball in a distance of one inch from its center of rotation $= a\,c\,n^2$, where a is a constant factor, and consequently from the triangle of forces, $f_1 = a\,c\,n^2\,h$. But the condition of equilibrium is $f_1 = c + Q$, or $a\,c\,n^2\,h = c + Q$; that is, $n = \sqrt{\frac{c+Q}{a\,c\,h}}$; $a = \frac{4}{12}\frac{\pi^2}{g} = .102$; therefore, $n = \sqrt{\frac{c+Q}{.102\,c\,h}}$.

It does not make any difference how the central weight is suspended; the downward pull on the balls depends on the relative movements only. If, for instance, Q moves 3 inches while c moves 2 inches vertically, then $f = c + \frac{3}{2} \times \frac{Q}{2} = c + \frac{3}{4}\,Q$, which now takes the place of $c + Q$ in the formula, and for $Q = o$, we have $n = \sqrt{\frac{1}{.102\,c\,h}}$.

The weight of the arms will generally make a slight difference in the speed, which can be calculated, but this is not necessary, for it can be regulated experimentally by the weight Q.

Figs. 3 and 4 show different ways of suspending the balls; h must always be measured from the intersection of the arms and spindle, as shown, and it will be seen from an inspection of the diagrams that for a given rise of the balls h will vary more in Fig. 3 and less in Fig. 4 than in Fig. 2. This variation of h for different positions of the balls will cause the governor to revolve at different speeds, for we have seen that the speed varies inversely as the square root of the height.

In Fig. 2 let n_1 be the speed for height h_1, n_0 for height h_0, and n_2 for height h_2; then

$$\frac{n_1}{n_0} = \frac{\sqrt{h_0}}{\sqrt{h_1}}, \text{ and } \frac{n_2}{n_0} = \frac{\sqrt{h_0}}{\sqrt{h_2}},$$

and by subtraction

$$\frac{n_2 - n_1}{n_0} = \frac{\sqrt{h_0}\sqrt{h_1} - \sqrt{h_0}\sqrt{h_2}}{\sqrt{h_1}\sqrt{h_2}},$$

but if we put $\sqrt{h_1}\sqrt{h_2} = \sqrt{h_0}\sqrt{h_0}$, the equation becomes

$$\frac{n_2 - n_1}{n_0} = \frac{\sqrt{h_1} - \sqrt{h_2}}{\sqrt{h_0}}.$$

The second member of this equation can be shown to be equal to $\frac{h_1 - h_2}{2\,h_0}$; therefore, $\frac{n_2 - n_1}{n_0} = \frac{h_1 - h_2}{2\,h_0}$.

The first member of this equation is variation of speed divided by mean speed; it is convenient to express this in per cent. of mean speed; thus

$$q = 50\,\frac{h_1 - h_2}{h_0},$$

where q is per cent. of mean speed. For example, $h_0 = 12$, $h_1 - h_2 = 2$ gives $q = 8\frac{1}{3}$ per cent. variation of speed.

If we figure out the result by extracting the square roots, we shall obtain a variation of $8\frac{34}{100}$ per cent., which shows my formula to be nearly mathematically correct within such limits as occur in practice. There is, of course, a mathematical proof for this, but I do not think it necessary to give it here, as a few calculations from both formulas will serve the same purpose.

The formula shows that variation of speed for a given rise of the balls is in inverse proportion to the mean height of the cone,

and therefore, the larger the governor the smaller the variation of speed. An increase of the height beyond certain limits may give an inconveniently low speed, but then it is only necessary to apply a central weight as in Fig. 2, to obtain any desired speed.

The governors here described may be called gravity governors, because gravity is one of the active forces. There are many forms of gravity governors, but the formulas here given are sufficient for we have only to find the parts of the ball, and a normal to the curve will then give the height h as shown in Fig. 5. If the curve is a parabola with its axis in the spindle, then h will not vary for different positions of the ball, and there would be no variation of speed on that account. Very nearly the same result may be obtained with other forms, for instance, the cross-armed governor shown in Fig. 4. Governors have been constructed on this principle, but they have failed on account of a lack of stability, the balls would never come to rest and there would be incessant fluctuations in the speed of the engine. The remedy is to add a spring or change the governor so as to cause it to revolve at different speeds for different heights, thus making it questionable whether any advantage was obtained over the simple Watt's governor or the loaded governor, Fig. 2. The reason for this will be given later.

Governors operated by spring and centrifugal force have come much in use in later years, and are now generally preferred for gravity governors on throttling engines.

On governors directly attached to the engine shaft springs are a necessity. In a gravity governor there must be a certain fixed relation between the active forces and the mass of the governor weights, for one of the forces is gravity which is proportional to the mass and the other force is equal to this. In other words, we can only increase the regulating power by increasing the mass, and consequently the inertia in the same proportion. The loaded governor shown in Fig. 2, with arms at right angles, is no exception to this, for the effect of inertia in a connected system is directly as the mass, the movement and the leverage, that is, as the mass multiplied into the square of the movement, which is really nothing but a definition of moment of inertia in a convenient form for governors. We can therefore not increase the regulating power of this governor without increasing the resistance of inertia of the governor weights in exactly the same proportion. I shall later come back to this important subject.

In a spring governor we may increase the spring tension to any desired extent without increasing the weight of the balls by simply increasing the speed of the governor and thus obtain a quicker action, and also greater stability then would be possible with the gravity governor. With springs also any desired degree of isochronism may be obtained independent of the height of the governor.

There is a very important class of spring governors called shaft governors which will be specially treated here, and the following is offered as an introduction: c, Fig. 6, is a ball which can slide on a radial line on a disk keyed to the engine shaft. This ball is supposed to be connected to a shifting eccentric which is not shown, and which for the purpose of this demonstration should be considered as of no weight. When the disk is revolved the ball would fly out, but is prevented from doing so by a helical spring as shown; this spring will therefore be in compression and the centripetal force of the spring is equal and opposite to the centrifugal force of the ball. The centrifugal force varies directly as the distance from the center of rotation, and the spring may be chosen of such a length that it shall exert a pressure on the ball varying exactly as centrifugal force, for as the tension of the spring varies directly as the amount it is compressed it will only be necessary to give it such a length that it shall be fully extended when the center of the ball coincides with the center of rotation. Let this be so, then if the disk is revolved at a certain uniform speed the ball will be under the action of two equal and opposite forces, no matter where it is placed within its range of movement. Let the position of the ball shown in the figure be its innermost position, then under the conditions assumed the compression of the spring for this position must be equal to the distance from center of ball to center of rotation, say 6 inches; when a governor spring is so adjusted it is often spoken of as having full theoretical tension, this being understood as the necessary condition for isochronism, but tension here must be understood relatively, for it will, from the explanation just given, be seen that the tension of the spring may vary greatly, still the only condition for isochronism is that it shall be compressed 6 inches to start with. Neither does the form of the spring make any difference in this respect, if we use a flat spring the initial deflection must be 6 inches. In this example no account is taken of the centrifugal action of the eccentric and other parts connected with it; this should not be neglected when designing shaft governors, for it will in some governors have a considerable influence on the initial deflection of the spring.

In Fig. 7 we have a ball a under the influence of centrifugal force; A is the center of rotation and the ball moves on a radial line $a\ b$. Centrifugal force may then be represented by ordinates to a slanting line $A\ f$. In an isochronous governor the deflection of the spring would be measured from the center A on the line $A\ b$, and the spring tension being proportional to the deflection and equal to the centrifugal force of the ball would, like this, be represented by ordinates to the slanting line $A\ f$. But we may draw other slanting lines, for instance, $e\ g$, and let this be the line of spring tension, we have then $A\ f$ as the line of centrifugal force, and $e\ g$ as the line of spring tension. The deflection must now be measured from e on the line $e\ b$, for at e there is no deflection. Let the innermost position of the ball be at a, then the initial deflection of the spring is $e\ a$, while in the former case it would be $A\ a$, we have therefore now less initial deflection. At o the spring tension is equal to centrifugal force, and the ball will therefore be in equilibrium there, but to the left from o centrifugal force is in excess of spring tension, and to the right from o spring tension is in excess of centrifugal force. Therefore, supposing the disk to revolve at a certain constant speed with the ball in equilibrium at o, then if the ball be moved from this position to the left it would not be in equilibrium; there would be an excess of centrifugal force which would bring it back to the position o, and if it be moved to the right from o there will be an excess of spring tension which will also carry it back to o. But suppose now that when the ball is at o it holds the eccentric in such a position that not enough steam will be admitted in the cylinder to do the work, then the speed will decrease, there will be a diminution of centrifugal force, and the ball will move toward the center of rotation and finally come to rest in a position between o and a, where it will admit sufficient steam, but with the ball in this position the governor must revolve at a slower speed, for otherwise the ball would not be in equilibrium there. Again, let the ball be in equilibrium at o, and suppose some load to be thrown off the engine, then the speed will increase and this will cause the ball to move to some point to the right from o, where it will finally come to rest, but the speed will be permanently increased here, for centrifugal force must be balanced by the spring at this point. Now it is not an isochronous governor for the speed varies for different positions of the ball, and it will be seen that the shorter we make the initial deflection of the spring the greater will the variation in speed be. "Full theoretical tension" for ordinary shaft governors cannot obtain in practice for the result would be the same as for the gravity governor with invariable height of cone, that is, the ball would never come to rest, and the engine would be racing. But the discussion of this belongs to the advanced part of the theory and will follow later. We may draw any number of slanting lines through the point o, corresponding to more or less initial deflection of the spring and more or less variation of speed, but mean speed would in every case be the same if o is a central position.

After we have found the line of spring tension for perfect isochronism we can draw a line for any desired approximation to isochronism in the following manner: Let the ball at a admit just enough steam to run the engine alone, and let it at b admit steam for full load, then if we want the speed to increase 5 per cent., from no load to full load, we make $g\ f = 5$ per cent. or $\frac{1}{20}$ of $o\ o_1$. This is a simple rule, but the proof of its correctness is not quite as simple, and I think it is better not to give it here in the introduction, but it will appear later.

The nearer the center of rotation we locate the ball the smaller will the centrifugal force be, and it is therefore better to locate it a considerable distance from the center, but then the initial deflection of the spring will also be considerable, which necessitates a larger spring. The strength and deflection of springs can be calculated accurately. Professor Reuleaux gives a number of formulas in *Der Constructeur*; see also table of helical springs in American Machinist, August 18, 1892.

It is not often that the ball or fly weight is made to slide on or between guides. The most general practice is to have it fixed to the end of an arm which is pivoted to the governor wheel or carrier. Thus in Fig. 8 p is the pivot, and the ball moves between a and b. Let $o\ c$ be the line of action of the spring, then if we neglect other connected parts the initial deflection necessary for isochronism $= g\ e$, for if we should move the ball to d, centrifugal force would be in the direction $p\ d$, and then the spring cannot be in tension if the ball shall be in equilibrium there.

For any other position, for instance, a, a radial line $A\ a$ will represent centrifugal force, and $A\ h$ its component in the direction of the spring and $g\ e$ would be the deflection of the spring; and we see from the principle of similar triangles that for a constant speed there must for different positions of the ball exist the same relation between the active centrifugal force and the deflection of the spring, which is the only necessary condition for isochronism. Therefore, if $g\ e$ is the initial deflection, we have "full theoretical tension." When the spring is not pivoted on the center line of the arm, the deflection may be found by similar but less direct methods. Governors with two fly weights are more common than those with one weight, and what here has been said will of course apply to two or more weights as well.

In governors with eccentric of variable radius or eccentricity, as used on single valve engines, the centrifugal force of the eccentric and strap and the centrifugal effect of the valve and connecting parts is quite considerable. How to draw the line of spring tension for such governors can best be shown by an example. In Fig. 9, C is a fly weight and E an eccentric and strap, and $a\ d$ is the line of action of the spring. C weighs 20 pounds and moves 3 inches, while E weighs 40 pounds and moves 2 inches; and there is another fly weight which is supposed to be an exact counterpart of C. The governor makes 4 revolutions per second, and therefore centrifugal force for each inch of radius $= 4^2 \times .102 \times$ weight $= 1.63 \times$ weight. A line $A\ m$ parallel to the spring line measures 12″, and therefore for position b centrifugal force in direction of the spring $= 1.63 \times 12 \times 20$ pounds $= 391$ pounds; and $A\ n = 10''$ gives a centrifugal force of 326 pounds for position a. Now in Fig. 10 make $a_1\ b_1 =$ the deflection of the spring when the fly weight moves from a to b; then make $b_1\ m_1 = 391$ pounds and $a_1\ n_1 = 326$ pounds to any convenient scale, for instance, $\frac{1}{2}'' = 100$ pounds, and the slanting line $m_1\ d_1$ will be the line of spring tension for perfect isochronism, but for weight C only. We must now find the centrifugal effect of the eccentric, valve and connecting parts. Let the weight of the valve and other reciprocating parts be 40 pounds, and let their movement be equal to the full throw of the eccentric, we have then a centrifugal effect from this cause as if half this weight or 20 pounds was added to the eccentric, and proceeding as before, we find the combined centrifugal force in the direction of motion of E to be 240 pounds, and 40 pounds for the two extreme positions respectively. The effect on the spring will be in inverse proportion to the movements; so if we assume the spring to move 3″ the effect will be $\frac{2}{3}$ of the centrifugal force of the eccentric and reciprocating parts, and as this should be divided equally between two springs, one for each fly weight, we obtain 80 and 14 pounds for each. Now make $m_1\ f = 80$ pounds and $n_1\ e = 14$ pounds, and $f\ h$ becomes the actual line of spring tension for perfect isochronism, from which the line of approximate isochronism can be obtained as already explained. It will be seen that the effect of the eccentric and reciprocating parts, as far as the springs are concerned, is the same as if we had made the fly weights heavier and located them nearer the center of rotation.

An eccentric which is journaled on the engine shaft will take no part in the centrifugal action of the governor, and the tension and initial deflection of the springs must in such case be calculated from the fly weights alone. The centrifugal force of the connecting links and of the springs themselves will, of course, have some effect which can be calculated, but I do not think so close calculation will be of much practical value.

The centrifugal force should always be calculated as if the whole mass was concentrated at the center of gravity, for this will give the magnitude of the force correctly and it will also give the direction correctly whenever the revolving body can be divided symmetrically by the plain of rotation, nor is there any objection to this method in any case where the body is constrained to move in the plain of rotation as on shaft governors. The center of centrifugal forces is not the same as the center of gravity, it is always further removed from the center of rotation and that is probably the reason why some authors have got the radius of gyration in their formulas for centrifugal force instead of the radius of the center of gravity.

The most important considerations in regard to a state of equilibrium in governors have now been discussed, and I shall in the following chapters explain the nature of the movements of the governor weights and the action and efficiency of the governor under different conditions.

Some Notes of Travel.

By W. H. Booth.

Occasionally I get a business tour which takes me to some of the more out-of-the-way places. There are indeed in this country, though so small, places which are as much off the beaten track as any pioneer settlement in America. The town of Tewkesbury strikes one as being comparatively little known; it is not on a main line of railroad but away upon a branch, and it has the advantage of being upon a river—the Severn, which is navigable to fairly large vessels. Tewkesbury should be interesting to Americans because its special connection with history occurred at a time when the stream of American history had not yet branched off from that of England—before Columbus in fact had sailed for America. There was a big battle fought here, and the prominent among those slain were buried in the Abbey here, and one may yet see the remains in a glass case of that Duke of Clarence who killed the son of that Queen Margaret whom Shakespeare represents as speaking her mind so freely to Richard the Hunchback.

This Abbey church is notable as having been built about 805 years ago and is an excellent example of good masonry. What strikes one particularly as a peculiarity in so much of the old stonework of this and

other old buildings is that the carved stone moldings, round windows and recessed openings which are inaccessible to the eye except upon the outer face are carved and finished at the back exactly as upon the front, but you cannot see the back without a mirror. This is thoroughness of work which seems to show that the worker had some pride in his work. He could have made it appear just as it now does with one-half the labor, and not one in a thousand would have found it out for himself, but the worker would have known it was no better than a modern picture frame could he have foreseen these times. Some locomotive builders finish both sides of the coupling and connecting rods of their engines. This does not fit in with modern ideas of some men who will argue that it is a mere waste of money though it does render the rods interchangeable in every way. This a black back does not permit, and it gives also a character of thoroughness which must have its educational effect.

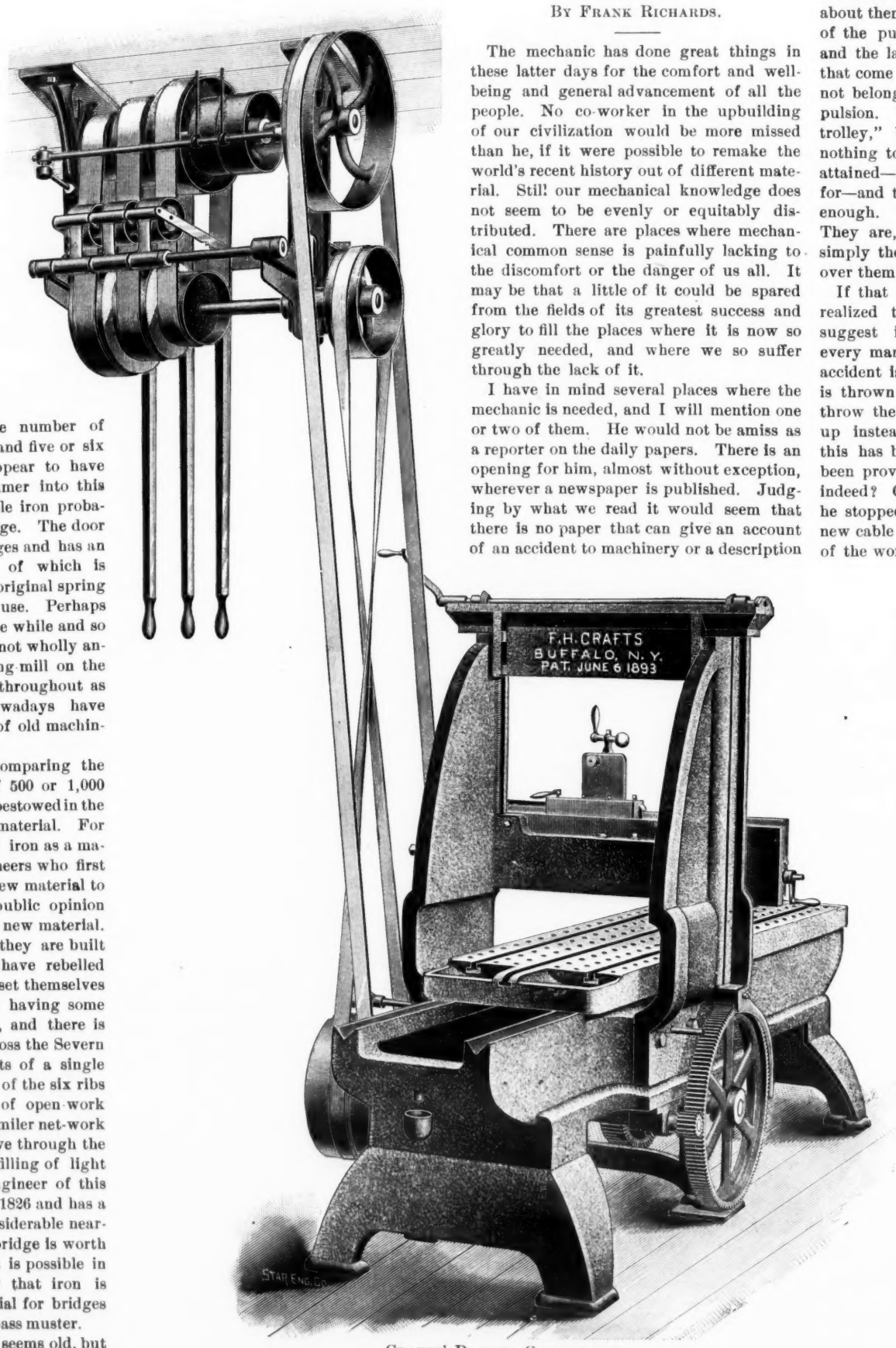
There is at Tewkesbury a door intended for the door of a strong room. It is of wood on which have been riveted, overlapping like the scales of a fish, a large number of iron plates about a foot long and five or six inches in breadth. They appear to have been beaten out by the hammer into this form from lumps of malleable iron probably produced in a Catalan forge. The door is hung on a pair of big hinges and has an enormous lock, the spring of which is claimed by the verger as the original spring some hundreds of years in use. Perhaps he has kept his eye on it all the while and so knows. But Tewkesbury is not wholly ancient, for there is a big flouring mill on the river said to be as modern throughout as possible. All the mills nowadays have cleared out their whole stock of old machinery and put in rollers.

It occurs to one when comparing the work of to-day with that of 500 or 1,000 years back that more care was bestowed in the earlier days of the use of a material. For example let us take the use of iron as a material for bridges. The engineers who first used iron for bridges had a new material to deal with in the face of public opinion which would be averse to the new material. Had they built a bridge as they are built to-day public opinion would have rebelled against the ugliness. They set themselves therefore to build structures having some pretense of good appearance, and there is a cast-iron arched bridge across the Severn at Tewkesbury which consists of a single span of large curvature, each of the six ribs built up of eight segments of open-work casting stayed laterally by a similer net-work and carrying the roadway above through the agency of a similar spandrel filling of light cast-iron. Telford was the engineer of this bridge, which was erected in 1826 and has a span of 172 feet which was considerable nearly seventy years ago This bridge is worth seeing as an example of what is possible in design with cast-iron. Now that iron is recognized as a proper material for bridges anything however ugly will pass muster.

A building 800 years of age seems old, but in the city of Bath, not far from Tewkesbury, I was crossing the city between the two railroads and stumbled across some work over 1,600 years of age in the shape of a large Roman swimming bath of very solid build and only wanting a roof to place it as it was in the days when our Roman progenitors were colonists here. Now we read a deal about the Romans having used swords of copper or bronze, as though they had no steel, but how did they cut and dress all the massive masonry of which this large bath is constructed? They must have had steel tools for this purpose even though they used bronze for their swords. Indeed from carpenter's tools found at the old Roman city of Silchester, which is now being explored, steel seems to have been used for tools. Are we to conclude that it was too expensive to use for swords which would be made from bronze—a metal that could not be used to cut wood or stone?

Crafts' Planer Countershaft.

Though there is, of course, not nearly so much occasion for changing the speed of a planer as there is for changing the speed of most other machine tools, it frequently happens that an advantage would result from being able to change the speed somewhat, especially where the character of the work and of the metals operated upon varies greatly. In some cases such a change has been provided for by erecting two countershafts, connected by a belt running on cone pulleys, but this has the disadvantage of being awkward, and of changing the backing speed as well as the cutting speed, which is not desirable, since the backing speed should be kept at the maximum for a given planer, regardless of the work done upon it.



Crafts' Planer Countershaft.

By the use of the countershaft shown, three different speeds are secured for cutting, by bringing into action any one of the three vertical belts shown, while the backing pulley being on the upper shaft, always moves the platen back at the same uniform and maximum speed regardless of the cutting speed. These countershafts and planers equipped with them are made by F. H. Crafts, corner Seventh and Hudson streets, Buffalo, N. Y.

Mechanical Common Sense and the Safety of the Public.

By Frank Richards.

The mechanic has done great things in these latter days for the comfort and well-being and general advancement of all the people. No co-worker in the upbuilding of our civilization would be more missed than he, if it were possible to remake the world's recent history out of different material. Still our mechanical knowledge does not seem to be evenly or equitably distributed. There are places where mechanical common sense is painfully lacking to the discomfort or the danger of us all. It may be that a little of it could be spared from the fields of its greatest success and glory to fill the places where it is now so greatly needed, and where we so suffer through the lack of it.

I have in mind several places where the mechanic is needed, and I will mention one or two of them. He would not be amiss as a reporter on the daily papers. There is an opening for him, almost without exception, wherever a newspaper is published. Judging by what we read it would seem that there is no paper that can give an account of an accident to machinery or a description of a novel machine or mechanical process or anything involving the slightest mechanical technicality without going into absolute absurdities about it. This is not of so much importance in itself, only that it shows the general ignorance of all mechanical matters not only in the writers but also in the readers or in the great mass of the public.

This general mechanical ignorance is in evidence in a thing that is before everybody's eyes in all our cities. With the advent of the motor car or the cable car—and the street car propelled by other means than horse flesh keeps coming, and coming to stay—the matter of guards or fenders in front of the wheels becomes a question of great importance. I suppose few have thought of it as it deserves to be thought of. The horse cars have been run all these years with comparative safety. The casualties have been few and generally unavoidable, and have not been always fatal. No better guard can well be placed in front of a car than the horses themselves. The horses instinctively avoid stepping upon a person, if they can help it, and their length gives the driver some chance to stop the car before the wheels can crush the victim. But when the motor cars begin to run, the thing about them that most attracts the attention of the public is the number of accidents, and the large proportion of fatal accidents that come in with them. The danger does not belong to any particular mode of propulsion. We hear much of "the deadly trolley," but the trolley generally has nothing to do with it, except for the speed attained—and that's what we are all crying for—and the difficulty of stopping quickly enough. The accidents are nearly all alike. They are, in the great majority of cases, simply the killing of people by running over them.

If that is the trouble, as soon as it is realized the remedy should immediately suggest itself. Why run over and kill every man, woman or child who by any accident is caught in front of the car or is thrown before the wheels? Why not throw the person to one side or pick him up instead of running over him? Why, this has been thought of and means have been provided for doing it. Have there, indeed? One would scarcely believe it if he stopped to look seriously at one of the new cable cars upon one of the great streets of the world. If we were told that the car is a modern and occidental car of Juggernaut, for crushing and killing as many victims as possible, the statement would be more easily credible. The bar and grating at the end of the car come just low enough to do the preliminary cracking of the bones, and the bar in front of the wheels being placed a little lower serves to reduce the subject a little finer before he is ready to be operated upon by the wheels for the final crushing. The whole contrivance is not always employed upon the victim. The bars are sometimes sufficient to kill before the wheels get there.

Evidently mechanical common sense has not had a hand at it. There should be no difficulty in providing reasonably satisfactory and usually efficient wheel guards and the saving of many lives thereby. There are cable cars in existence, within my knowledge, that carry guards well adapted to their purpose and that are not in the habit of killing people. If we were enumerating in detail the points that an efficient guard should possess, we would be describing very nearly the guards as they are in use upon the road alluded to.

The guard should come down absolutely as close to the ground and to the rail as possible. For this reason it should never be attached to the end of the car. The height of the car above the ground varies considerably with the weight of the load, and the guard must be placed high enough to clear the ground with the heaviest loads, and in addition to this the teetering of the car requires the guard to be placed still higher so that the bottom of the guard is generally at about the right height to catch a person and roll him along, squeezing him as he rolls, but in no way preventing him from getting under the wheels. As no guard can properly be

placed at the end of the car it is better to have no pretense of one there, better to remove it entirely and leave as much clear space as possible between the platform or the bottom of the car and the ground, keep the lowest step as high as the public will stand it without grumbling and keep everything else about the end of the car as much higher than the step as possible.

If the guard is attached to the truck and placed as close in front of the wheels as possible its height will not be affected by the weight of the load nor by the tilting of the car, and it may therefore be placed at once and for all the time down close to the track. It is practicable to carry it within one inch of the track and never to vary from that. The guard being as close as possible to the track should project forward horizontally under the center of the car, the faces slanting backwards on each side so that the advance of the car will tend to throw off any obstruction to the nearest side. The faces of the guards should also slant backward from the vertical at the top so that they may more easily run under the obstacle and lift it up instead of climbing over it. The faces of the guards should be smooth, preferably of metal, and should have no projecting nuts or bolt heads.

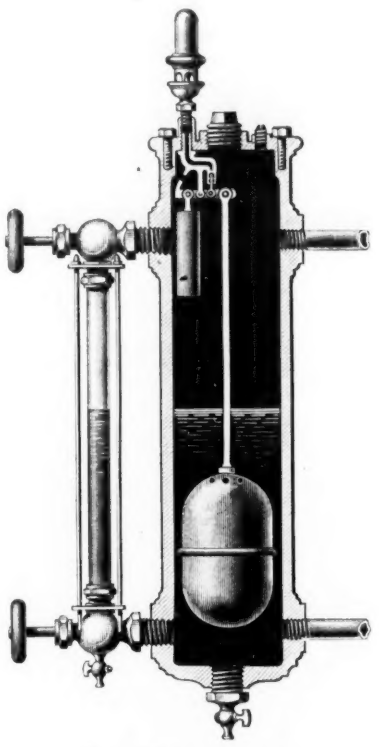
There is but one car line, within my knowledge, that nearly approximates to these conditions. The other cars carry various things that are usually evidently worse then useless as a protection. The favorite device with the electric cars seems to be a vertical board in front of the truck, and of various heights from 4 to 8 inches from the track.

Mechanical common sense may perhaps be permitted to ask why it is that the locomotives upon the New York elevated roads have no wheel guards of any kind, good or bad, at either end. Whoever falls before the advancing wheels, whether a passenger jostled from an unfenced and crowded platform, or a luckless and thoughtless employe upon the track, is inevitably ground to death. Only lately the victim was a track foreman, and "nobody to blame."

Lately, not far from my neighborhood, as I learn through the papers, a steam mangle drum exploded in a laundry, killing two persons and injuring a number of others. The coroner's jury censures the proprietors for not employing a more competent person for regulating the pressure upon the drum, and that is presumably the end of it. But may not mechanical common sense ask why such a death trap should be set up? How can the pressure upon a steam mangle drum be "regulated"? I never heard of one of them having a safety valve, and if it had one it should not be subject to the "regulating" of a cheap employe. Such machinery should be safe beyond all the possibilities of tampering or neglect, and mechanical common sense asks: If not, why not?

Low Water Alarm.

We present herewith a sectional view of a low water alarm, which seems to be reduced to its simplest elements, and to include nothing, which, by getting out of order, is liable to prevent the alarm from working. A copper float which is supposed to be filled with air, and to float upon the surface of the water, rising and falling with the water level, will almost inevitably leak in the course of time, fill up with water, and thus become inoperative; or, rather, it operates all the time, until taken out and repaired. To obviate this difficulty, the closed float is done away with entirely in this alarm, and a hollow, globular casting substituted, which is open at the top, and intended to be always filled with water. When thus filled and submerged, as shown in the engraving, it is over-balanced by the smaller solid weight at the other end of the lever, and the valve which admits steam to the whistle is kept closed, but should the water fall too near the bottom of the glass, and the hollow weight thereby become suspended in steam instead of water, while yet remaining filled with water, it then overbalances the solid weight, descends and opens the valve, an action which, as will be seen, ought to be quite reliable, and, in fact, it proves to be so in practice. One



Low Water Alarm.

cause of this is that things are so arranged that no packing is required for the valve or stem, and the valve is made of Tobin bronze which does not corrode. Moreover, all the working parts of the alarm are attached to the cap of the column, so that by taking out a few tap bolts and removing the cap all the parts come out with it, and can be inspected or repaired if necessary. It is especially to be noticed that this can be done without disturbing any connection to the boiler. Arranged thus in the column, only two connections have to be made to the boiler, these connections being such as are necessary with any other form of water column, so that where a column is to be used, no extra connections are required for the alarm. The gauge cocks can be tapped into this column in the usual manner if desired. The alarm is made in three sizes, either cast-iron, finished or unfinished brass, by the Ashley Engineering Company, 136 Liberty street, New York.

Twenty-one Inch Drill Press.

This machine has wheel and lever feed combined, and is made with or without back gears. The table is adjusted vertically by means of worm, and worm gear in connection with rack. The gears and racks are all cut from solid stock. The base is planed square with the column, and is provided with T-slots for bolting work or fixtures. The spindle is operated by a worm and worm gear in connection with a steel rack and pinion, and has a vertical movement of 11". The spindle is 1½" diameter and is bored to the Morse taper. Height of machine, 76"; weight, about 800 pounds; vertical movement of table, 15½"; diameter of table, 16". This tool is designed to meet the requirements for all purposes for light and medium work. It is made by J. E. Snyder, Worcester, Mass.

Twenty-one Inch Drill Press.

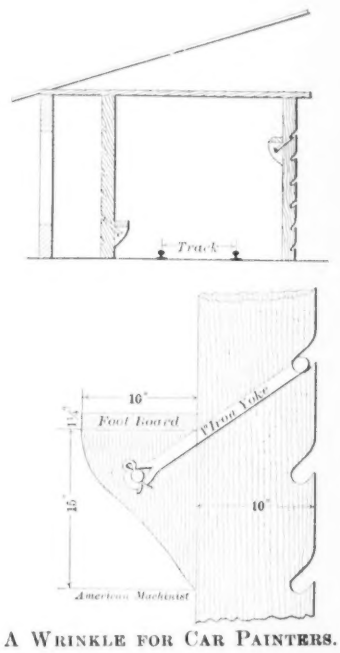
On page 37 of the *Pictorial Times*, London, of January 17, 1846, we find the following paragraph: "Experiments of a highly satisfactory nature are being made with regard to the application of electro-magnetism to railway propulsion. The great difficulty to be surmounted is the weight and size of the galvanic batteries requisite for sufficient energy. To obviate this difficulty, it has been proposed to have stationary batteries at regulated distances and to make the rails themselves the conducting lines of the batteries." Tne idea involved is even older, we believe, than 1846. As soon as it was shown that it was possible to make an electro magnet, the application of the principle was extended to a great number of mechanical combinations. —*The Engineer* (London.)

Mr. P. Sievert, of Dohlen, Saxony, proposes the manufacture of glass pipes by rolling down molten glass in grooves or flutes and using a core to complete the formation of the pipe or tube. Molten glass is poured from a reservoir or hopper into the bite of two rollers. The rollers are placed horizontally, each being provided with grooves. A core of suitable dimensions is placed in the grooves. When the core is moved downward the molten glass follows the movement and forms a tube the dimensions of which are determined by those of the ring-shaped space between the contours of the grooves and the core. The speed at which the core is lowered is regulated according to the circumferential velocity of the rollers.

Old Dominion Notes.

By R. S. W.

Norfolk, Virginia, has its machine shops like every other town in the Union, but unlike most other cities where there is more than one, they are all neighborly grouped together along one street, and within a range of three blocks. Norfolk being a large shipping center and possessing very few manufacturing plants, it is easily understood that they are all repair shops.



A Wrinkle for Car Painters.

The machine tools in these shops are somewhat antiquated, although here and there I saw some modern tools. The best tool I saw was an old English lathe with flat shears. The bed was of stronger design than any machine of its type and size built to-day, but it was naturally weak in its head stock and foot-stock. Its bed was possibly twenty feet long and was supported by inverted U-shaped legs about every four feet. It was doing good work, and I see no reason why it will not be in service a generation hence.

Here I learned something new concerning surface plates. If a Yankee workman was asked to scrape a valve seat to a true surface, he would require a good Brown & Sharpe surface plate. The Norfolk machinist simply has his patternmaker fix one up for the occasion out of a piece of pine lumber, and so far as I could observe it answered his purposes just as well, and the valves worked just as tight as if a heavy iron plate had been used.

As the Norfolk mechanic is of a more languid disposition owing to climatic conditions than his northern and western brothers, I am inclined to believe the wooden surface plate was better for him, and he produced results fully as quick by not being handicapped by the weight of the plate.

In one of the shops I saw a very cheap imitation of the log carriage made by the Stearns Manufacturing Co., of Erie, Pa., being built. The chief industry of the foundries from appearances is the casting of propeller wheels and car wheels for use around saw-mills and on logging roads. They use good molding sand and the workmanship shows care and interest on the part of the molders.

A trip across the river to Berkeley brought me in contact with my friend Matt. Reed, general foreman of the Norfolk & Southern R. R. shops, who called my attention to a new wrinkle in his paint shop invented by the car painters for rapidly painting the sides of coaches. It is an arrangement well

adapted for all car works and many other places, and is explained in the sketches.

Two Baldwin compound locomotives have been in service on this road for the past year, and have cost nothing whatever for repairs and maintenance as yet. The question of coal economy between them and the simple engines in service is still unsettled among both officials and employes. Both engines were in the roundhouse while I was there, and close examination of the crossheads discovered no unusual wear on them, an item contrary to past experiences in this type of compounding.

A pair of drivers in the wheel lathe having their tires re-turned, showed nearly three-eighths hollow wear on the crank side, while the opposite side was hardly noticeable; this was undoubtedly due to poor counterbalancing on the part of the builders.

Over the other branch of the river brought me to the Navy Yard at Portsmouth, where I found the battleship "Texas" still "under construction." Two or three boiler makers or calkers were pottering away their time, while a dapper officer "detailed in charge" happened to be on deck holding a flirtation with his mustache. The only change I could see since my visit three years ago is the erection of the spars. Like everything else our mighty Congress tries to handle, the "Texas" grows slow, and her hull will probably be rusted away and gone by the time she is ready for her armament. The cruiser "Atlanta" is also in the dock being overhauled, having been found unseaworthy after her officers had been court martialed for delaying to sail after being ordered to sea by the Navy Department. There is also a monitor "under construction" whose keel was laid in 1865.

The cruisers "Detroit" and "New York" are anchored in the Roads below here opposite Fortress Monroe. It is impossible for the "New York" to come up to the Navy Yard here, as the channel is only twenty-six feet deep, while the pride of our navy requires twenty-eight feet to swim in. In the shops hereabouts, when a man is slow and has to be told when, where, and how to do his work, he is termed a "Navy Yard mechanic," which explains about what type of workmen they grow to be in government work, although any naval officer will tell us that "they can use none but the very best of skilled mechanics in the Yard."

LETTERS FROM PRACTICAL MEN.

Standard Sizes for Keys.

Editor American Machinist:

In your issue of April 27th I find an article by "Bell Crank" concerning my standard key-way gauges. As a regular reader of your paper allow me to state my experience in this matter.

In 1880 being employed as machinist-fitter at the surface table in a crane works near Glasgow, I had to mark off the key-ways on all sorts of wheels, and found the prevailing way of laying out the larger key-seats with steel rule and compasses very wasteful of time. Therefore I contrived an applicance, *c* Fig. 1, which gives a correct center line and corresponds with the so-called center square, an instrument which as I found subsequently had been in general use throughout the U. S. A.

As stated above, this instrument gave a correct center line, rectangular to which the lines for the key-seat had to be drawn on the boss of the wheel. To simplify this manipulation I constructed my first key-way gauge, *g* Fig. 2, consisting, as explained by "Bell Crank," of a plate of steel, hardened and finished to width of key, the edges of which are bent to right angles, the bent part resting against the inside of the bore of the wheel, while the gauge rests on the end of the boss, giving at once the depth of the key-way.

Having made a number of these gauges and finding them answering very well, I decided to standardize the dimensions of keys and bring them in the shape of time-saving gauges into the machinery market. I took now patents for my instruments in most of the industrial countries of Europe.

Having in the meantime taken employment as draftsman in one of the leading machine works in Glasgow, I began to consider which proportions of dimensions could be best adopted for keys and entered into correspondence with many first-rate engineering firms in Great Britain and the continent of Europe in order to ascertain this. Comparing the tables of keys adopted by them with those given by Reuleaux, Molesworth, Uhland and others, I found that those given by Molesworth: "Width of key = ¼ diameter of shaft + ⅛"; thickness = ⅞ of width" were nearest to the average, and therefore adopted those dimensions for my gauges.

There being very few gauge makers in Great Britain I tried in vain to find a reliable firm to manufacture my gauges for the market, so I constructed a complete sample set and secured orders wherever I showed it.

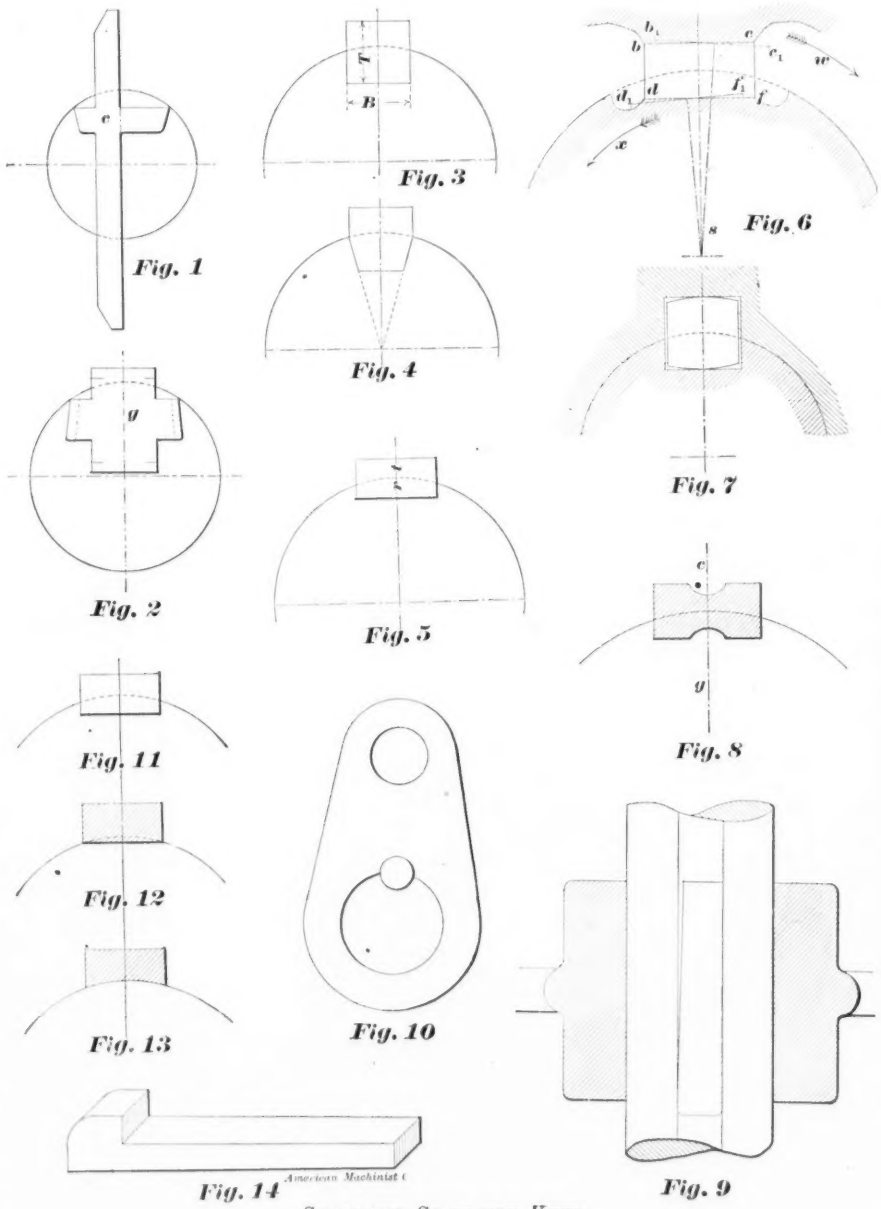


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8 Fig. 9 Fig. 10 Fig. 11 Fig. 12 Fig. 13 Fig. 14

Standard Sizes for Keys.

With these orders I left Glasgow for Freiburg in Baden, my native place, where I started small works for making my key-way gauges. In 1884 I brought my first 50 sets into England, and by the end of 1885 saw them adopted as standard by more than 200 leading firms of Great Britain and Ireland.

The difficulty of getting manufacturers of keys to adopt a standard for their keys led me to undertake making keys myself. To get the necessary funds for this undertaking I started for America with about 100 sets of my gauges and landed in New York, June 2, 1887. I at first met with some discouragement, but having paid extremely high duty on my instruments I was determined not to take them back to Germany, and got at last, after many disappointments, my first order from the Pioneer Iron Works, Brooklyn, and in less than five months saw my gauges adopted by fully 100 different firms in the U. S. A. and Canada. On September 13th I read a paper about my instruments before the Civil Engineers' Society in Cleveland, O., which was greatly approved of.

Being now possessed of the necessary funds I began on returning to Freiburg to construct special machinery for the manufacturing of keys and soon found a good market for them both on the continent and in Great Britain.

During the last nine years, whilst introducing my key-way gauges in fully 600 engineering firms, I have had ample opportunity of getting the opinion of a great many engineers, professors of engineering, superintendents, foremen, etc., both on the continent, in Great Britain and the U. S. A., and have come to the conclusion that few attempts have ever been made to determine by practical experiment the best dimensions for keys, so proportioned as to stand the strains which they have to transmit. In constructing my metric system of standard keys, I compared the tables of at least thirty leading continental firms, and not two of them were alike. In the U. S. A. I found very few tables and great variety in the dimensions of keys. Those tables hung mostly on the walls of drawing-offices, and rarely, if ever, in the workshops. I even found that a leading firm in Philadelphia had tables, but that their men did not work to them.

In the U. S., where machine construction is more specialized, I found the best machinery for making key-seats, and the tool room system pretty well insured interchangeability of parts, but gauges for keys I found very seldom, except in works where the construction of machine tools was a specialty, and where feather keys were mostly used. The proportion of the key to the corresponding shaft is with machine tool-builders generally: Breadth of key = ¼ diameter of shaft; thickness of key = ¼ diameter of shaft, and the key sunk the same depth into the shaft as into the boss of the wheel. This may give satisfaction in a case where the key has to slide longitudinally over the shaft, the key in this case being a *feather* key, Fig. 3.

This key is supposed to bear chiefly sideways, and therefore this side-bearing surface is to be large enough to make the key stand the compression of the materials.

In the instance of key to be fixed in the boss and to slide on the shaft along with the wheel, it is better to give it the form of Fig. 4, the sliding surfaces being radial.

All these feather keys are not easy to standardize in general, because the shafts and wheels they have to give motion to are often constructed, not only to transmit torsion, but also to withstand bending strain, etc. In the U. S. A. where the building of machinery was originally and chiefly based on machine tools, the dimensions for keys were mostly those for feathers, and I had often immense difficulty to convince the engineers in the U. S. that narrow keys sunk deep into the shaft and deep into the boss would never give satisfaction, and that a key which is to withstand the full torsive strain of the shaft should have a broad bearing surface top and bottom; its thickness to be sufficient to allow of being driven home and drawn out again without bending up, and sunk equally deep into boss and into shaft, see $r = t$ in Fig. 5. It should bear chiefly top and bottom and fill up the key-seat sideways as well as possible.

Suppose the shaft *s*, Fig. 6, to move in the direction of *x*, and the wheel towards *w*, and if the material of boss and shaft at the side of the key be removed, the bearing surface *b c* would move to *b I* and *c I*, and the surface *d f* to *d I* and *f I*. In this case the key is compressed at *c I* and *f I* because the two lines set at right angles to the radius, moving in opposite directions, form an acute angle.

A key that is not broad enough takes the form of Fig. 7. It begins to rock, especially if the strain is applied alternately in both directions.

This theory led me to construct a key which would bear only on those parts which are actually exposed to strain and having no material round what I call the neutral axis *c g*. This *grooved* key, Fig. 8, has the double advantage of giving less work in fitting and at the same time a better bearing surface.

In the U. S. A. I found a good many first-class engineers, who insisted that a sunk key should chiefly bear sideways and *not* top and bottom, because this would draw the wheel or crank out of angle. But I am quite convinced that if the tapered key bears equally its full length top and bottom that will not be the case. I have often found, on the contrary, that the key-seat on the shaft and seat in the boss do not run exactly parallel lengthways, Fig. 9, and then if a key is driven in which is supposed to bear sideways, it fits tight only at the one end of boss sideways and at the other end sideways in shaft, this causing the wheel to work loose. Supposing the key-seat in boss and the key-seat in shaft to be perfectly parallel and a perfectly parallel key to be driven in, it would fit only tight at that end of boss from which it was driven in. To avoid this, those key-seats would have to be made slightly tapering sideways, which is a very troublesome and costly job, and may only be applied at the end of larger shafts for holding cranks, disks, etc., and is well in its place where those have been shrunk or forced on by hydraulic pressure. In the latter case, a steel pin about ⅛ to ¼ diameter of shaft, slightly tapered, driven into the tapered hole, Fig. 10, will be far cheaper and secure better results. The keys so far described are *sunk* keys, and my system of gauges gives the dimensions of them as follows: Breadth of key = ¼ of diameter of shaft + ⅛"; thickness of key = ⅛ of diameter of shaft + $\frac{1}{10}$"; depth of key-seat in shaft = $r = t$, Fig. 11; taper of key = ⅛ to the foot.

Flat keys, Fig. 12, *not* sunk in the shaft are used where the wheel has to transmit only part of the torsive power of shaft.

Hollow keys, Fig. 13, are used where little power has to be transmitted, and where the friction caused between key and shaft is sufficient to do this. Headed keys, Fig. 14, are applied in all cases where it is impossible to apply a drift to draw the key, the proportion of the key-head being as sketch indicates.

"Bell Crank," in kindly bringing my key-way gauges to the notice of your readers, states correctly enough that my gauges do not give any dimensions for the taper; but in the table I furnish with each set of gauges, I have remedied this by recommending a taper $\frac{1}{8}''$ to the foot, and as I found that on all modern machines for key-seating there are adjustments on the table on which the wheels are set, it is very easy to maintain uniformity of taper in all the cases desired. "Bell Crank" objects, first, that my gauges are not applicable to any but the sized hole for which they are made, because if used on a smaller or larger hole it makes considerable difference in the depth of the key-way, and also, secondly, that it would be too expensive to have a different gauge for each fractional sized shaft. To this I reply, that the gauges have to maintain a standard. If a shaft is 2″ standard, the gauge is correct to that size, but may be applied for $2\frac{1}{8}''$ shaft, the breadth being of course the same, and the depth would be in this case about $\frac{1}{100}''$ greater in hub, which is scarcely perceptible when fitting a key. The next gauge is $2\frac{1}{4}''$, which gives dimensions for all bores up to $2\frac{1}{4}''$. Of course, the gauges for 8″ to 12″ shafts cannot be made to give dimensions for every intermediate size, but are made for 8″, 9″, 10″, 11,″ 12″ shafts, as a different gauge for each fractional sized shaft would, as "Bell Crank" justly objects, make the system too expensive.

Messrs. Pryibil and Shellenback recommend a taper of $\frac{1}{4}''$ to the foot. In my experience I have come across cases where heavy wheels on vertical shafts had come loose, their keys having been made to similar taper. In my opinion it is not necessary to give more taper than $\frac{1}{8}''$ to the foot, because shafts are nowadays mostly made of mild steel, and if the keys, as usual now, are made of steel rather harder than the average shafting material, there is no fear of sticking to or tearing up the surfaces. Keys having much taper, if not very accurately fitted, tend to throw wheels or pulleys out of true running.

In conclusion, allow me to state that the introduction of a standard is not an easy but a very costly matter, and unless I had been able to offer in my gauges an appliance by which much time can be saved, I should never have had so great a success.

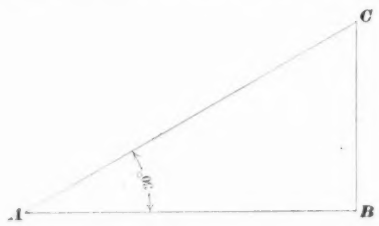
Julius Roemmele.

Frieburg, Baden, Germany.

Use of Slide Rule.

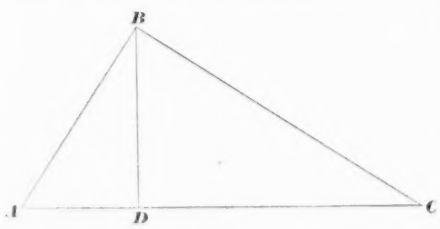
Editor American Machinist:

Having noticed from time to time in the Questions and Answers columns of your valuable paper inquiries as to the methods of computing the various functions of triangles, it seemed to me that a few simple



explanations of the use of the slide rule for the solution of such calculations might be of interest to some of your readers.

Probably many people have been puzzled how to use the three scales engraved on the under side of the slide, the upper one of which is marked S and the lower one T. In



what follows I shall presume that the readers of the American Machinist are acquainted with and able to use the ordinary slide rule; in such case the following remarks will be quite clear.

If the slide is taken out, turned over face for face, and reinserted in the rule so that the scale S shall be at the top next to scale A of the rule, and the scale T at the bottom next the scale D of the rule with all the indices coinciding, we then have on scale A the sines of all the angles given in degrees on scale S, beginning at the left with the angle 34′ 23″ whose sine is .01; then proceeding to 5° 44′ 39″, whose sine is .1 in the middle of the rule, and ending with 90° whose sine is 1.0 opposite the right index of the rule.

In the right-angled triangle $A\ B\ C$, if $A\ C$ be taken to be equal to 1 or unity, then $B\ C$ is the sine of the angle $B\ A\ C$, and $A\ B$ is the sine of the angle $A\ C\ B$, that is

$$\text{sine of } A = \frac{B\ C}{A\ C}, \text{ and}$$

$$\text{sine of } B \frac{A\ B}{A\ C},$$

the sine of a right angle as B being always equal to unity.

The general relationship of the sides and angles of triangles is contained in the following theorem:

The sides of a plane triangle are proportional to the sines of the angles opposite; that is

Side $A\ C$: Sine B : : Side $B\ C$: Sine A : : Side $A\ B$: Sine C.

In the above figure let angle $A = 30°$, consequently angle $C = 180° - (90 + 30) = 60°$. Now with the slide set as stated, with all the indices coinciding, that is with 90° set opposite 1 (the right index) we find 0.5 on scale A over 30° on scale S, and 0.867 on scale A over 60° on scale S. These are therefore the respective lengths of the sides, namely

$A\ C = 1$, $B\ C = .5$ and $A\ B = .867$.

We demonstrate this thus on the slide rule:

A | | To Side $A\ C$ | Find Side $B\ C$ | Find Side $A\ B$
S | | Set Angle B | Over Angle A | Over Angle C

Now suppose as shown angle A to be 30° and the opposite side $B\ C$ to be 8 feet, then we have

A | | To 8 | Find 13.8 | Find 16
S | | Set 30° | Over 60° | Over 90°

whence we have $B\ C = 8$, $A\ B = 13.8$ and $A\ C = 16$ feet.

In this way, when one side and the opposite angle of *any* triangle, as well as one other side or angle are known, the remaining sides and angles are at once found.

It was asked in a former number of your paper how to find the distance $A\ B$ when the side $B\ C = 5$ inches and the angle $A = 40$ degrees, we have

A | | To 5 = $B\ C$ | Find 5.95 = $A\ B$ | Find 7.78 = $A\ C$
S | | Set 40° | Over 50° | Over 90°

In the same paper it was asked how to find the length of the perpendicular $B\ D$ in right-angled triangle $A\ B\ C$, when $A\ B$ is known to be 30 inches and $B\ C = 40$ inches. Here the angles A and C must together be equal to 90 degrees. We therefore move the slide about until we find two angles on S opposite 30 and 40 on A, which together make 90°; such are 37° and 53° respectively, then opposite 93° we find 50, which is the length of the side $A\ C$. We now set the angle 90° on the slide opposite the side $A\ B$ or 30 on scale A of the rule when we have

A | | To 30 = $A\ B$ | Find 24 = $B\ D$ | Find 18 = $A\ D$
S | | Set 90° | Over 53° | And over 37°

whence $D\ C = 50 - 18 = 32$ inches.

We have thus by a very simple process obtained all the angles and sides of these two triangles. All other cases will be found equally simple and accurate.

I find the subject grows, so must reserve my remarks respecting the scale T and the middle scale, which is one of equal parts, for a future occasion.

Wm. Cox.

Shot vs. Punch.

Editor American Machinist:

Referring to the article on Good Steel, page 11, of No. 39, I wish to call attention to the fact that while in the case of the punch all the power is transmitted through the body of the punch from ram of the punching machine, and the punch usually fails by buckeling or upsetting, in the case of the shot all the energy is stored in the shot itself, and every atom contributes its share to supply power to pierce the plate. Supposing the shot to be made up of 10 disks of equal weight, then the pressure at the first separating plane would be $\frac{9}{10}$ that necessary to pierce the plate, at the second $\frac{8}{9}$ and at the last $\frac{1}{10}$.

This undoubtedly contributes somewhat to the better service of a shot as a punch than one could get out of the same piece of steel in a punching press.

I suppose you have all heard of the old hunter's experiment of shooting a candle through a board. I regret to say I have never tried it, but would like to hear from some one who has.

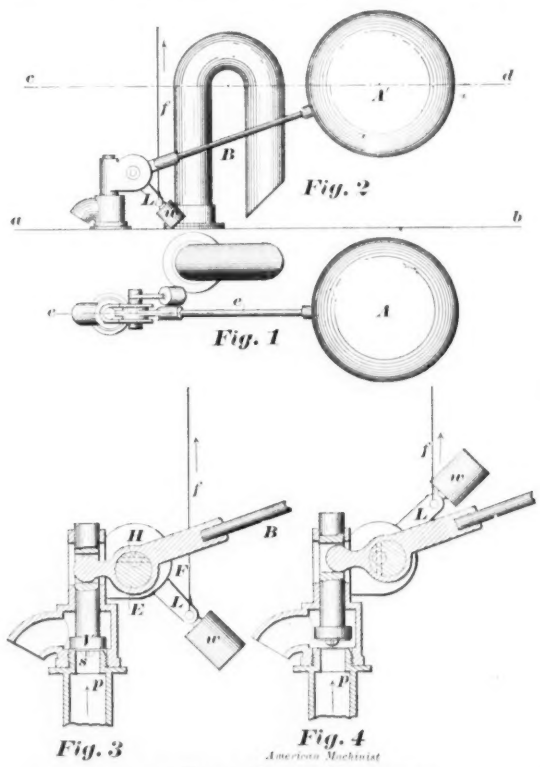
W. L. Clouse.

[We had in mind the difference in the action between punch and shot as exemplified in the candle shooting, but making all due allowance for this, it still seems clear that very great superiority is shown by the steel used in these shells, for it will be noticed that the very extreme point of the shells was intact after passing through the plate, which can only be accounted for, we think, on the ground that the steel was very much superior in strength and hardness to any ever met with in shop tools.—Ed.]

Sinking Key Beds.

Editor American Machinist:

We have not all got slot milling machines and are therefore compelled to use various makeshifts. My own experience is as follows: For shallow work such as key and feather beds, short in length, a radial drill does excellent work at far less cost than combined chipping and drilling. A pair of V-blocks doweled into accurate position sets any shaft at once truly radial with the column of the machine and practically no further adjustment is necessary.



Siphon Tank Valve Mechanism.

For deep cutter holes this plan is too slow, and the usual method is resorted to of drilling a row of holes as close as possible together and excavating the intervening bridges with cross-cut, etc.

For some time past I have adopted a modification of this plan not used to my knowledge elsewhere which reduces the subsequent hand-work fully one-half. Holes as nearly as possible equal to the width of slot are drilled leaving bridges of solid metal of a width equal to about three-quarters the width of slot. In the center of each bridge a leading hole is then drilled from $\frac{1}{2}$ to $\frac{1}{4}$ width of slot, but leaving a fair substance of metal on each side of the adjoining holes. The leading holes are then opened out to the same size as the first series, thus completely breaking down the bridges and extracting about 90 per cent. of all the metal to be removed.

I am confident you will agree with me as to the importance of ear marking and condemning impracticable processes wherever they are described, and more especially if they intrude upon your correspondence columns. I therefore venture to again call attention to my inability to obtain any results at all from Willich's black photo printing process under the recent heading "The Progress of Photo Printing," and to ask that the *modus operandi* shall either be more correctly described, or that the formulæ be publicly withdrawn.

Percy J. Neate.

Rochester, England.

Siphon Tank Valve Mechanism.

By Frederic R. Honey.

A very ingenious and novel device has been brought to my notice by the inventor, Mr. W. H. Edmondson, an employe of Messrs. Pratt & Whitney.

It is an improvement in siphon tank valve mechanism, the primary object of which is to dispense with one of the two valves ordinarily employed, thus diminishing the first cost of the apparatus. With this improvement it is also possible to use a tank of smaller capacity than that which has heretofore been made, and supply the same amount of water as formerly at the time of flushing.

These objects are attained by the mechanism illustrated in the accompanying drawings, in which Figs. 1 and 2 are respectively a plan and elevation of the valve box, the ball with its lever and connections, and the siphon. The line $a\ b$, Fig. 2, represents the bottom of the tank, and the broken line $c\ d$ the level of the water. Figs. 3 and 4 are enlarged sections of the valve box at the line $e\ e$, Fig. 1, representing the valve closed and open, and the mechanism for lifting it corresponding to the two positions.

The ball A', Fig. 2, is forced upwards by the water, and operates through the lever B in keeping the valve V on its seat s, shown in the section Fig. 3. In this position the valve V prevents the admission of more water through the service pipe p.

The ball lever B, Fig. 3, is enlarged at F to admit the eccentric sheave E. This eccentric sheave is keyed to the spindle H, which is also fastened to the lever L. The eccentric sheave E, the spindle H and the lever L thus form substantially one and the same piece, while the eccentric sheave E is free to revolve within the ball lever B, which takes at this point the form of an eccentric-strap F. The water ordinarily stands at the level $c\ d$, Fig. 2. When it is required to empty the tank, the lever L is raised by pulling the wire f in the direction indicated by the arrow, Figs. 2 and 3, into the position L, Fig. 4. The eccentric sheave revolving with it, raises the ball lever, releasing the valve, which is at the same time forced upwards by the service water which enters through the pipe p. The water rises until it reaches the bend of the siphon, when the tank is nearly emptied.

On releasing the lever L, the weight w restores the eccentric sheave to its original position, Fig. 3. The ball A is now at its lowest position. The valve V therefore remains above its seat until a sufficient quantity of water has entered the tank to raise the ball A and lever B into the positions shown in Figs. 1 and 3, when the valve again closes connection with the service pipe, and prevents the admission of more water.

Reading, Penn., reports that great numbers of counterfeit silver dollars have been put in circulation there, and that they are lighter than the genuine silver dollars. A counterfeiter who is not satisfied by the profit to be made out of coin of full weight deserves to be given exemplary punishment.—*Philadelphia Ledger.*

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
203 BROADWAY, NEW YORK.

PUBLISHED WEEKLY AT
203 Broadway, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
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NEW YORK, OCTOBER 19, 1893.

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Headquarters at the Fair.

During the continuance of the Chicago Exposition the AMERICAN MACHINIST will have its headquarters in the space allotted to the Mechanical Press in Machinery Hall. The exact location is Section No. 27, Column K 37. Word can be left with the attendant there by any one who is desirous of meeting a representative of this paper, who may at the time be engaged elsewhere on the grounds. As the majority of our friends who visit Chicago during the continuance of the Fair will spend a considerable portion of their time in Machinery Hall, we invite them to make use of our facilities there by having their mail addressed in our care as above, where it will be cared for and delivered on demand either by our own representative or by the person who cares for the space in which our desk is located.

A Mechanic Arts High School.

It is said that the latest educational scheme evolved in Boston is the establishment of a mechanic arts high school, which, it is explained, is to form the connecting link between theoretical and practical education, and it is stated that this is to form the crown and climax to the city's common school system.

It is claimed by some of those who advocate manual training that, other things being equal, a boy who, along with his study of books, has some training of the hands and eyes gets along better with the books even when the subjects treated in the books have no direct relation to manual skill, or in other words are confined entirely to theoretical, literary or classical subjects. Though there is probably no conclusive proof of this, it seems not improbable, because such training undoubtedly does more fully develop the senses by which impressions are received. And there can be little doubt that in proportion as we possess and improve those means by which we receive impressions of material things we advance, not only in absolute knowledge but in the power to assimilate and make practical use of knowledge.

The familiar history of Laura Bridgeman shows how the difficulties of acquiring knowledge are greatly increased by the destruction early in life of one or more of the senses. Though of unusual mental ability naturally, this woman, by being deprived when a child of sight and hearing, remained in almost absolute ignorance until well grown, when, by the exercise of enough patience and ingenuity to have liberally educated a hundred ordinary persons, she was tolerably well educated by making use of those avenues to the brain which still remained intact. It is reasonable to suppose that had she been deprived of these avenues, her education would have been impossible, and that as they were increased or their efficiency improved, the task of imparting knowledge became easier. There is no doubt that training of the hands to be skillful in manipulation and exact thinking, mainly because it simply improves one of the avenues by which impressions are received and classified, and it is not improbable that in educational schemes too little attention has been given to the training of the eye and hand by systematic exercises, as we are quite sure too little attention has been paid to teaching apprentices other things besides the mere manipulation of tools and materials.

The time honored plan of sending a boy to school and teaching him practically nothing except what he can learn from books, or from a teacher who is as ignorant as himself of all that is outside of books, and then practically abandoning all of that while a trade is learned, all the book learning being crowded into one period and the manual training into another, the two being sharply separated from each other, is almost certainly wrong. The natural way, the way in which a father would teach his son if our modern methods had not delegated this duty to others, would be to teach the use of the bodily faculties, and along with this the principles involved, or the *theory*. So far as the combination of manual training tends toward this natural method of teaching or of imparting information it is undoubtedly good; it is only when people go further and declare that a school can teach a trade better than it can be taught in a shop where that trade is followed that the mistake is made.

Steamboat Inspection Laws.

Another probable attempt by Congress to revise the steamboat inspection laws is already meeting with advance criticism. Without regard to the merits of any bill that looks to greater safety so far as the engineering department is concerned, it is certain to be opposed by the owners of steamboats. It will make the cost of boilers greater, and reduce the pressure allowed on boilers now in use, but the main reason for the opposition is that the standard of engineers will be raised, creating a demand for men of better abilities, and who will expect and demand better pay. At present really good engineers are handicapped by not very competent men, who stand ready to take their places at less pay than a good man should be expected to work for. The cheapest man who can get through an examination is the one generally selected.

Raising the standard is in the interest of good engineers, and in the interest of safety. It is really absurd that with progress in everything else the standard of engineers should remain the same. There is just as good reason why there should, year by year, be better engineers, as there is in the instance of lawyers or doctors, but very much progress is practically impossible, so long as it is not essential to the securing of a position.

Precisely the same trouble exists in this respect in the instance of stationary engineers, except that it is somewhat intensified by the fact that in their case in most parts of the country no examination or license whatever is required. But stationary engineers are more likely, in their work, to come under the direct observation of proprietors, which is, to some extent, an advantage.

Regarding the tests of boilers, and the materials of which they are constructed, there will very likely be the old fight of inspectors against a change. Altogether it is doubtful if any very material change will be made in existing laws, either as regards boilers or engineers. A rather sweeping bill will quite likely be introduced, which will be "amended" to cover just about what is covered by the present law.

Percentage of Elongation.

What is perhaps one of the most curious and at the same time one of the most confusing things connected with tests of structural materials as these tests have been up to this time conducted, is in the method of computing percentage of elongation in specimens subjected to tensile strain. As every one knows who has seen specimens of steel or wrought-iron pulled in two in the testing machine, there are two distinct reductions of area of the specimen, *i. e.*, there is that reduction which takes place during the earlier part of the test, and is nearly uniform throughout the entire length between the gripping jaws, and then that which takes place locally, where the reduction in size is sharply defined, and in or near the middle of which reduced section the fracture takes place, the length of this sharply reduced section being the same in specimens of any length. Since ultimate elongation is dependent upon reduction of cross-sectional area, it of course follows that the greatest elongation per small unit of length takes place at and near the point of fracture, and if the specimen be so short that this reduced section forms a very large proportion of the length of the entire specimen, then the percentage of elongation for that specimen will be high; whereas if the specimen be very long, the proportion of the sharply reduced section to the entire length will be small, and the percentage of elongation will therefore be also small, even though precisely the same materials are tested in each case, or measurements are made on different lengths of the same test-piece. If in every tensile test the elongation of the specimen was compared with what it would have been had the specimen been 100 units in length between the gripping jaws, then percentage of elongation would have had a definite meaning, and that meaning would have been the same wherever and whenever the term was used, but under the present method it may easily happen that percentage of elongation of say 5 per cent. in a full length bridge member may indicate precisely the same qualities as 50 per cent. elongation of a specimen cut from a forging for the engine of a U. S. cruiser, and no one can have any idea of what either of them mean until the length of specimens is taken into account. To this fact is to be attributed much of the surprise expressed by persons unfamiliar with these matters that the percentage of elongation shown by, say forgings of steel, should never be nearly approached in bridge members, though the material purports to be much alike. This confusion is one of the evils hoped to be done away with by the adoption of the uniform methods of tests which is now proposed, and of which Mr. Gus. C. Henning gave some account in our last week's issue.

In our issue of September 21st we published an account of a cylinder boring machine designed by H. Bollinckx, mentioning it as a French machine. This was a mistake as the shop of the Société Anonyme des Ateliers de Construction is at 95 Chaussée de Mons, Brussels, Belgium.

Literary Notes.

THREADS AND GEARS, a Guide of Instruction to the Young Machinest [*sic*] on the change gears of his latne in the cutting of screw threads. By G. W. Dixon Published by the author at Spring Lake, Mich.

This book which purports to make clear a subject which the author imagines is too deep for most machinists, succeeds simply in so beclouding the matter as to make it entirely unintelligible. It does nothing to help a novice to understand the principles involved in change gears, and gives no evidence that the author understands them. In fact some of the rules given are much more mixed than the mixed numbers they pretend to deal with, and one unfamiliar with such matters will only be misled by attempts to fathom them. The price is 50 cents.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(511) W. H. F., Chester, Pa., writes: I am an apprentice in a machine shop, but I desire to become a mechanical engineer. Do you think the Correspondence School of Mechanics is a good thing? *A.*—Yes.

(512) L. F. R., Jersey City, N. J., writes: I have a number of porcelain plates. The dimensions are: 12 inches long, 6 inches wide, and $\frac{5}{16}$ inch thick; they are somewhat warped. Are there any means of straightening them? *A.*—We do not know of any means of straightening them, and we are in doubt as to the possibility of doing so.

(513) C. A. M, Worcester, Mass., writes: Some time ago you published an illustration of a machine for balancing pulleys which were placed in the machine and then revolved, and the balance weights were so placed as to obtain a balanced pulley. Kindly give date of issue in which I may find this illustration. *A.*—January 12, current volume.

(514) A. L. C., New Haven, Conn., asks: Have you ever illustrated and described a movable or shifting eccentric used as a steam engine governor, and in which num-

bers of the AMERICAN MACHINIST can the best cuts and description be found? *A.*—The illustrations and description in our issues of November 20, 1880, and December 11, 1886, may be of service to you.

(515) L. C. M., Wilkes Barre, Pa., writes: Kindly advise me as to the best paint to use on iron pipes, etc., submerged in water which contains a considerable amount of acid. *A.*—We do not know of any paint that we could recommend for this purpose, and doubt very much if you can obtain a paint that will be satisfactory under the conditions named.

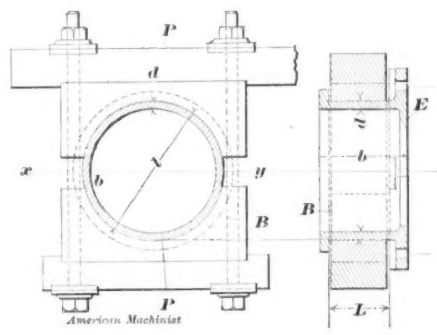
(516) W. L. H., Pasco, Washington, writes: Please give me the correct answer to the following question: If a flue should burst and let the water and steam all out of the boiler, how would you fill the boiler by the injector? *A.*—We should first put in a new flue, or, if the flue is of a comparatively small diameter, and it cannot be obtained in time, we should plug up the flue holes. If, then, a boiler under steam pressure is near at hand we should take steam from this boiler to the injector, and fill the boiler in the usual way. If steam cannot be obtained in this way the boiler cannot be filled with the injector, as the latter cannot be made to work without steam.

(517) J. N., Fort Wayne, Ind., writes: I am about to build a small steam engine with a cylinder 1⅛ inches diameter and 2 inches stroke. I would like to know the dimensions of steam and exhaust ports, diameter of piston rod, diameter of connecting rod, diameter of crank-pin and shaft, diameter of both ends of crank and the weight of fly-wheel. *A.*—Length of steam ports, ⅜ inch and ⅛ inch wide; exhaust port the same size; diameter of piston, ¼ inch; diameter of connecting rod at the small end, $\frac{3}{16}$ inch; diameter of crank-pin (if overhung), ¼ inch; diameter of shaft, ½ inch; diameter of crank on shaft, 1 inch; diameter of crank on crank-pin, ½ inch; weight of fly-wheel rim about 20 pounds with a mean diameter of 6 inches. 2. What should be the stroke of pump for this engine, diameter of plunger being about $\frac{5}{16}$ inch? *A.*—About ½ inch. 3. I intend to use a piece of 6 or 8-inch gas pipe for boiler, how long a piece will I require? *A.*—About 18 inches.

(518) T. W., Newark, N. J., asks: What is the difference between a "square foot" and a foot square? *A.*—The term "square foot," in its widest sense, is one of the units of measurements of the areas of surfaces; if, for instance, a surface is 24 feet long and 6 feet wide, it contains $24 \times 6 = 144$ square feet; if it is 24 inches long and 6 inches wide, it contains $\frac{24 \times 6}{144} = 1$ square foot. In a similar way the area of cylindrical surface, a sphere, or of any other surface, can be expressed in square feet. The term "foot square" indicates the form of the outline of a plane surface; it indicates that the surface is bounded by four straight lines at right angles to each other; it also indicates the length of these lines. If, for instance, a surface 1 foot square is mentioned, it is understood that a square is meant, and that each of its sides is 1 foot long; or, if a surface 20 feet square is spoken of, it is understood that this surface is bounded by 4 straight lines at right angles to each other, each 20 feet long. From the foregoing, it will be seen that a surface 1 foot square contains 1 square foot, and a surface 20 feet square contains $20 \times 20 = 400$ square feet.

(519) H. G. H., Bristol, Pa., writes: Please inform me who was the inventor of the screw propeller; also of what was it made, and how was it made? *A.*—The screw propeller as an instrument of propulsion is of comparatively late date. We find it proposed by Hooke in 1680, Duguet in 1727, Pancton in 1768, Watt in 1780, Bramah in 1784, Fulton in 1794, Cartwright in 1798, and Shorter in 1802. In 1804, two years before Fulton began building the "Clermont," Colonel John Stevens, of Hoboken, N. J., built and ran a steamboat on the North River, in which he employed a screw propeller. The engine and propeller are still preserved at the Stevens Institute of Technology. In 1806 he built the "Phenix," which made the trip to Albany from New York in 1807, shortly after Fulton had succeeded in accomplishing the same thing with the "Clermont." From this time to 1836 numerous arrangements of screw propellers were proposed, but no extended use was made of this method of propulsion until Francis Pettit Smith, of Hendon, Eng., and Captain John Ericsson, brought the subject forward, and by their energy and perseverance proved the practical value of screw propellers for ships. Both obtained patents for the use of the screw in 1836, and from this time forward its application to steamships has steadily increased. (*Appleton's Cyclopedia of Applied Mechanics.*) We presume that all the early propellers were made of cast-iron.

(520) W. J., Florence, Mass., writes: The accompanying sketch represents a common brake, such as is used for measuring power. *B* is a plain drum with no spokes on the inside, its diameter is denoted by *l*, and its length by *b*. It is bolted in place by means of bolts in flange *E*, the outside flange is for the purpose of preventing the brake from slipping off the drum. I would like to know how to calculate the thickness *d* of the cylindrical drum, leaving the two flanges out of the question, so that it will safely withstand a force 2 *P* tending to crush the same. The force *P* must be supposed to act at the top and bottom only, and not divided up on the whole bearing surface of the shoes as they are made of wood, and therefore give little or no resistance to keep the drum from springing. *A.*—For all practical purposes, results sufficiently accurate may be obtained by considering the



drum to be cut by the plane *x y*, and then consider the upper half to be a simple beam of a length *l* supported at the ends and loaded at the center with a load *P*; the thickness of the drum is denoted by *d* which corresponds to the depth of the beam, and the length of the drum is denoted by *b*, which corresponds to the breadth of the beam, all dimensions will be taken in inches. Hence the problem is now to find the depth *d* of a rectangular beam, its length and breadth and the load being given. The depth is found by the following formula,

$$\frac{6 \times P \times l}{4 \times S \times b} = d^2.$$

S denotes the stress on the outer fibers of the material, and if it be cast-iron we may take a value of 5,000 pounds for *S*. To show the application of the formula let us assume that the length *l* of the beam (the outer diameter of the drum) is 18 inches; the breadth *b*, 10 inches, and the load *P*, 10,000 pounds. Substituting these values for the symbols in the formula, we have,

$$\frac{6 \times 10{,}000 \times 18}{4 \times 5{,}000 \times 10} = 5.4,$$

the square root of 5.4 is 2.32, hence the depth *d*, that is, the thickness of the drum, will have to be 2.32 inches.

(521) C. C. H., Dunham, Ala., writes: I have been in the saw-mill business for the last four years, and as saw mills are generally located in some out of the way place, and the equipment of the machine shop usually consists of an old lathe and drill press with the scrap pile as a source of supplies, the machinist is very often called upon to do a job that looks at first sight to be almost impossible. I have a job on hand now that I would like some information about. A rod strap broke on one of the locomotives, and so wrecked the cylinder as to necessitate the putting on of a new one. The cylinders are inclined. What I wish to know is how to go about putting it on, as I have to do most of the fitting with the hammer and chisel. *A.*—We suppose that the new cylinder has been furnished by the builders, bored and planed ready to put in position excepting that portion of the saddle which fits against the boiler. Place the cylinder in as high a position as the saddle will allow, and the center line of the bore exactly parallel to that of the other cylinder. These lines should be extended beyond the fire-box so as to make sure that when the frames are put up they will clear the fire-box and have about the same amount of clearance from the outside of fire box; of course the horizontal distance between these center lines must correspond to the distance between centers of driving axle journals. The face on the new half saddle against which the frames butt must also be in line with that on the old half saddle so that when the driving axles are placed in position they will stand square with the frames. After the cylinder has thus been placed in position the amount to be chipped off the top of the saddle to fit the boiler can then be scribed off, and then taken down and chipped. If the saddle is cast separate the cylinder must be placed in position to the lines as explained above, and these will indicate the amount to be chipped off the cylinder.

(522) J. S., Houtzdale, Pa., writes: I have seen so many different rules for pump problems that I am at a loss to know which is right. I would therefore ask you to work out in detail the following problem: What should be the diameter of the water cylinder of a pump to deliver 1,500 U. S. gallons per minute; the plunger makes 50 strokes per minute, length of stroke 3 feet? Also what should be the diameter of the steam cylinder, the pump being placed at a depth of 165 feet from the point of delivery, the effective steam pressure is 45 pounds per square inch? An allowance of 20 per cent. for loss is to be made. *A.*—In taking the allowance for loss into account we add 20 per cent. to the number of gallons to be discharged, hence we make the water cylinder large enough for a discharge of $1{,}500 + 300 = 1{,}800$ gallons per minute. There are 7.48 gallons in a cubic foot, hence the discharge will be $\frac{1{,}800}{7.48} = 240.6$ cubic feet per minute; during this time the plunger makes 50 strokes, therefore the discharge for each stroke will be $\frac{240.6}{50} = 4.8$ cubic feet; dividing this by the stroke we obtain the area of the water cylinder $\frac{4\,8}{3} = 1.6$ square feet; the corresponding diameter is 17¼ inches. Before we can determine the size of the steam cylinder, we must find the total pressure on the piston in the water cylinder. The water has to be raised through a distance 165 feet. A column of water 1 foot high and 1 inch square weighs .434 pound, but, approximately, we may say that this column gives us a pressure of .5 pound, this allows for ordinary friction, hence the pressure per square inch of the water piston will be $165 \times .5 = 82.5$ pounds, and multiplying the area of water piston by this pressure we have $230.33 \times 82.5 = 19{,}002.225$ pounds for the total pressure on this piston, which is the pressure that the piston in the steam cylinder must overcome. The effective steam pressure is 45 pounds, hence the total area of the steam piston must be $\frac{19002.225}{45} = 422.27$ square inches, the corresponding diameter will be 23¼ inches nearly. Here as in a previous answer we have made no allowance for loss in the steam cylinder. If this loss is also to be 20 per cent. we must add this to the area of the steam piston as previously found, and we obtain $422.27 + 84\,45 = 506.72$ square inches, the corresponding diameter is 25⅝ inches nearly.

(523) F. H. C., Allegheny, Pa., writes: Kindly give me a formula for finding the diameter and length of locomotive crank-pin. *A.*—You will find this subject thoroughly discussed in our issues of February 7, 21, March 7, 21, April 4 and 18, 1889. These papers also contain rules for computing the dimensions of locomotive crank-pins, and also tables of dimensions of crank-pins for various types and sizes of locomotives working under various steam pressures, so that the suitable size of crank-pin can at once be obtained without any computations. 2. Please give a formula for computing the dimensions of the equalizing lever. *A.*—In determining the dimensions of an equalizing lever, we generally find that the design of the engine will establish the thickness of the lever. For instance, in many engines the pads which connect the boiler to the frame are placed at each side of the fulcrum, and the nuts which fasten the pads to the boiler will be along one side of the equalizing lever. There should be at least ⅛ of an inch clearance between these; and since the levers are generally made of a symmetrical form, it follows that the design and position of pads will generally establish the thickness of the equalizing lever; this thickness rarely exceeds 1½ inches, and for small engines, say with cylinders 9 inches in diameter, will sometimes be ⅞ inch. The design of the engine also establishes the length of the lever, so that the only dimension which has to be computed will be the depth. In order to do so, we must know the load which the lever has to support. For eight-wheeled passenger engines this load is found by subtracting from the total weight on the drivers that part of the weight which is not supported by the lever, such as the weight of driving wheels, axles, etc., and then divide the remainder by 4; the result will be the weight or load which one of the two equalizing levers has to support. Suppose that the total weight on the four driving wheels of an eight wheeled passenger engine is 52,020 pounds, and that of this weight 12,000 pounds is not supported by the lever, we then have $\frac{52{,}020 - 12{,}000}{4} = 10{,}005$ pounds for the load on the equalizing lever. The lever may be considered to be a rectangular beam supported at each end, and loaded at the center. The depth of a beam of this kind is found by the following formula:

$$\frac{W \times l}{8{,}000 \times b} = d^2;$$

in which *W* denotes the load in pounds, *l* the length (from center to center of spring hangers) of the lever, *b* the breadth or thickness and *d* the depth, all the dimensions to be taken in inches. If the breadth of the lever is 1½ inches, its length 60 inches, and the load 10,005 pounds, we then have:

$$\frac{10{,}005 \times 60}{8{,}000 \times 1\frac{1}{2}} = 50.02;$$

and the square of 50 02 is 7.07, which is the required depth at the center; the depth at the ends of the lever should be ½ of that at the center. The foregoing formula has been obtained as follows: For a beam supported at the ends and loaded at the middle, we have: $W = 4 \times \frac{S \times b \times d^2}{6 \times l}$; in which *S* denotes the stress on the outer fibers of the lever; the other letters denote the same quantities as before. The value of *S* is taken at 12,000 pounds, hence the above may be written:

$$W = 4 \times \frac{12.000 \times b \times d^2}{6 \times l};$$

which reduces to:

$$W = \frac{8\,000 \times b \times d^2}{l};$$

from which we get:

$$\frac{W \times l}{8{,}000 \times b} = d^2, \text{ as given before.}$$

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila., Pa. See p. 12.

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

For Cypress Tanks and Vats, address W. E. Caldwell Co., Floyd and Main Streets, Louisville, Ky.

Speed Gage, shows speed and all variations. Geo. T. McLauthlin & Co., Boston, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton Avenue, Philadelphia, Pa.

12-inch breech-loading rifled mortar & mounting, w'ght 118,000 lbs., front Gov't B'ld'g, World's Fair; des'n on applica'n. Builders Iron F'dry, Prov., R. I.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO. 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Notes from the Fair.

Editorial Correspondence.

Those engaged in the mechanic arts will not fail to be satisfied with the exhibit of the Nicholson File Company, of Providence, R. I., which is located in Manufacturers Building. Probably no such complete exhibit was ever before made in this line of manufacture. The space allotted the company has been well improved in the way of making an artistic display that is both interesting and instructive, and representative of the progress of modern art and machinery in the production of the useful, and to the eye of the mechanic, the beautiful. One finds from a card that the exhibit consists of more than 3,500 articles, comprised principally of over 3,000 distinct varieties of files, a statement which he will take on faith rather than verify by looking at each individual item of exhibit, or at least by counting.

The arrangement consists of a revolving drum 6 feet long and 4 feet in diameter completely jacketed, to use a term common with steam engineers, barrel and head, with more than 1,300 files of fine grade [X. F.], Swiss pattern, a revolving turret with [X. F.] files radiating from the globular top, two upright cases ornamented with more than 1,300 files from regular stock and two flat cases containing an assortment of more than 300 varieties of files. This, to say nothing of file sections and tools and implements having relation to the use of

files or to the production of fine surfaces, and to drawers containing files many of them so small that they might be blown away if exposed to a Chicago draught. All these files from $\frac{1}{8\,8}$ inch diameter and 1 inch long up to 24 inches flat, cut from 8 to 424 to the inch, show a wonderful adaptation of machinery to the production of something universally used.

It would be a sheer waste of energy, and too great a tax on the patience of the reader to undertake anything like an enumeration, by name or purpose, of the different files shown; files from those about as thick as a piece of thin bristol board to those of the heaviest pattern, files of most of the common and easily named sections to those requiring the skill of the geometrician to find exact designating titles descriptive of the outlines of their cross-sections, but for which the file maker finds names of his own that sometimes identify better than they describe; straight files and files curiously crooked, files for the metals, hard and soft, files for wood and for every other material used in the arts, files for the dentist, the manicure, the watchmaker and the blacksmith, for hot metal and for cold metal, and, strangest of all, files for filing bread.

Files cut 424 to the inch set the machinist thinking of fine measurement as a step from the old proverbial $\frac{1}{100}$ of an inch up to the $\frac{1}{10000}$, and beyond, of the present. A flat file of this cut feels very much to the touch of the finger like a well finished surface, but the thumb nail will very readily engage with its asperities.

One is apt to wonder how all the forms of files were called into existence. They have come about through the steady efforts of manufacturers to produce something that would be useful, and from a demand on the part of those who use files for something quite different from anything in the market. County debating societies frequently tackle the momentous question as to the precedence of supply and demand. In the matter of files, which comes first is settled by dividing the honors. The file is a very ancient tool, and the variety of forms are the efforts of a hundred generations to adapt means to an end. The original file may have been a stone, jagged or smooth to suit different conditions; the modern file is an artistic production of skill and machinery.

Near by the Nicholson exhibit is that of Kearney & Foot, of New York, not so extensive or complete as the former but representing some good examples of file-making, and a little further on that of McCaffery File Company, of Philadelphia; and elsewhere are several other exhibits, notably from Switzerland, famous through many years for the production of fine files.

A German firm show in Machinery Hall amongst other examples flat files made up of blanks upon the faces of which are keyed the files proper, consisting of strips about $\frac{1}{16}$ inch thick cut on both faces. Of course, the blank will last indefinitely, the strips being renewed as they are worn out.

Steam pumps and pumping engines are well represented, the largest exhibit being by Henry R. Worthington, of New York, whose pumps are found on all parts of the grounds, the greatest aggregated capacity being in the pumping station through which water is supplied for the fountains, fire service and for general purposes. This station has a capacity of 40,000,000 gallons a day, furnished by four pumping engines, one "high-duty" (horizontal), one horizontal triple-expansion and two vertical compound. There are also here two large fire pumps—underwriters' pattern.

In Machinery Hall there are seven smaller pumping engines with a combined capacity of about 25,000,000 gallons for supplying water for condensers and for cooling purposes, and alongside these 25 pumps of various sizes and for various purposes. Besides these there are condensers and pumps in most of the principal buildings.

An interesting feature of the Worthington exhibit is a small pump in operation—borrowed for the occasion—that has been in use for 44 years, costing $8.40 for repairs. This pump looks a trifle old-fashioned, compared with present practice, but it shows that the late Henry R. Worthington made a pretty good steam pump nearly a half century ago. This pump will go back to its regular service at the close of the Fair; it looks as if it could do another 44 years.

The A. S. Cameron Steam Pump Company, of New York, has the advantage of being located by the large central water tank in Machinery Hall, connection being readily traced between one of their regular pattern pumps and a stream of water reaching the roof. The particular reason for this stream of water, as well as for others over the tank, is to show a particularly solid stream from a patent nozzle. The passer by seeing the stream—the effect—looks for the cause—the pump. The Cameron Company exhibit a considerable number of their well-known pumps, piston and plunger, horizontal and vertical, with and without flywheels, and for a variety of purposes.

Near by this exhibit is that of the Buffalo Steam Pump Company, Buffalo, N. Y., consisting of their regular line of steam pumps, independent condensers, etc., with which we have from time to time made our readers acquainted. Though not getting in their work in an apparent effort to fill the big tank, they have a tank of their own, and in their space an exhibit that is bound to get attention. This is in the shape of a hydraulic ram of unusual proportions, getting rid, in one way and another, of a large volume of water, and capable, it is said, of raising 95,000 gallons in 24 hours. This is pretty sure to attract attention, because it is out of the common, and makes some noise. There is also shown one of the smallest rams I have ever seen. The man in charge of this exhibit expresses himself as discouraged at the current ignorance in relation to this inexpensive and comparatively old way of raising water, and thought seriously of printing on suitable cards for distribution an answer to the question, "What makes the thing go?"

The Deane Steam Pump Company, of Holyoke, Mass., had several of their pumps in the Cold Storage Warehouse, which was destroyed by fire, but they still have several left. In the boiler house are two duplex with 7½-inch steam cylinders, 4½-inch plungers, and 10-inch stroke. In the power plant are two air and circulating pumps with 16-inch air, water and steam cylinders and 16-inch stroke, each in connection with a Wainwright surface condenser. The combination is very complete, making a neat arrangement. They have also a Deane condensing apparatus on a McIntosh & Seymour engine, the apparatus consisting of a vacuum pump with an 8-inch steam cylinder, a 12-inch water cylinder and 12-inch stroke. The company had, we believe, nine pumps in the Cold Storage Warehouse—seven pumping brine and water, and two feeding boilers against 300 pounds pressure.

M. T. Davidson, Brooklyn, N. Y., has, in the boiler house, two compound pumps large enough to be classed as engines; they are used for feeding boilers, and it is necessary to run slow, one at a time. The boiler attendant speaks highly of their performance, and they certainly appear to run very finely. He also has in power plant an independent condensing apparatus, doing duty for two 350 horse-power engines.

The John H. McGowan Company, of Cincinnati, O., have several steam pumps in operation, duplex and simple. One duplex is connected with a fountain in the tank, but as that is some distance away they have a fountain of their own in their space. This company is applying, to some extent, a different valve motion from that of their usual practice. In this jointed arms project sufficiently through the ports to be struck by the piston near the termination of its stroke, by which means steam is admitted to shift the steam valve.

In a deep well pump by the Downie Pump Company, of Valencia, Pa., there are two water pistons working in one cylinder or tube, one piston rod being hollow, the rod of the other piston passing through it. These piston rods and pistons are of equal weight, and the connection with steam cylinder is through levers so arranged that when one piston moves up the other moves down. The weight of the pistons and rods is by this arrangement taken off the steam piston, the result claimed being smoother running, a continuous stream of water and the possibility of higher speed.

Alongside the water tank is the exhibit of the Laidlaw-Dunn-Gordon Company, of Cincinnati, Ohio, consisting of duplex, compound, underwriter and other pumps, some of them at work pouring water into the tank. This exhibit is a good one. Beside it is a drawing attraction in the shape of a waterfall of several feet in height, the prime cause of which is a centrifugal pump by Joseph Menge, of New Orleans. This pump supplies the waterfall with 300,000 gallons of water an hour. These centrifugal pumps, which are rather crudely, or at least inexpensively made, are used by Southern planters for drainage and irrigation purposes.

The attraction of moving water is provided for by the P. H & F. M. Roots Co., of Connersville, Indiana, in the Mining Building, who show in operation a rotary pump of a capacity of nearly 40,000 gallons per minute, pouring out a rather muddy stream of water from a small tank to which it is returned, and into which a good deal of dirt evidently finds its way. This, though—the muddy water—is all right enough, since the pump is especially recommended for irrigation purposes where mud must be frequently pumped. This pump is constructed on the principle of the Root blower, and if the mud is reasonably wet it all goes.

Beside this pump the company have on exhibition a line of their "positive" blowers for foundries and smith shops, and for other purposes, also blacksmith forges, gas exhausters, etc. The largest foundry blower shown is capable of delivering air for melting 23 tons of iron per hour. Another large fan for other purposes will give a blast pressure of twelve pounds.

The Connersville Blower Company, of Connersville, Ind., have one of their No. 4 positive pressure blowers in operation. It has a capacity of 12½ cubic feet of air per revolution, its normal speed being 200 revolutions per minute. As we expect soon to illustrate this blower, no reference to its construction will be made here.

The Conover Manufacturing Company and the Wheeler Engineering Company, both of New York, have condensers and pumps in connection with steam engines in the power plant, but no exhibits, I believe, except in such connections. In fact, it is the case with manufacturers of many steam engineering appliances that their exhibits are in use in such a way that they are not likely to be noticed. This is the case with the Knowles, the Blake, and the Snow, and other steam pumps, and with various smaller appliances used on and about steam engines and boilers.

H. W. Johns Manufacturing Company, of New York, put their work in evidence by their asbestos boiler covering on a large number of boilers, heaters and pipes in the power plant and elsewhere, besides which they have three regular exhibits, one of this wonderful heat-excluding, fire-resisting raw material, another showing some of the processes of manufacture—spinning, weaving, etc., and the other illustrating the uses to which asbestos goods are applied. In this last named exhibit is a large variety of manufactured goods—pipe covering, gaskets, washers, millboard sheathing, building felt, roofing, fireproof paints, etc.; also a fireman, or the semblance of one, clothed *cap-a-pie*, face, hands and all, in asbestos garments. Taken altogether, the exhibits of this company are very interesting as showing the progress made in this line of manufacture within a comparatively short period of time.

A line of portable forges by George Cummings, of San Francisco, Cal., is deserving of notice. They are equipped with the Cummings hand fan blower. There is not very much to a portable forge anyway, and there appears to be about as little to this one as to any I ever saw, which is one thing in its favor. The basis of the whole thing is a piece of gas pipe corresponding in size to the size of the forge. One end of this pipe is stopped tight, while the other end is fitted with a removable plug, for convenience in cleaning. Through one side of this pipe are two oblong holes, one being for wind from the fan, and the other for delivering wind to the tuyere. Imagine all other parts of the forge clamped to this pipe, and you have a picture of the forge ready for use. Thus the legs are of gas pipe suitably bent, fastened together in pairs, and so arranged that by the operation of a single thumb nut they are clamped to the pipe. The pan is similarly clamped to the pipe, as well as the blower, which delivers air through the bottom and through one of the holes in the pipe (the pan being clamped over the other hole). The shield is placed on the pan in any position desired, being held by two spring clips. The exhibitor will take the whole thing apart and assemble the pieces again in one minute, and you can easily do it yourself in two minutes, without the use of a wrench or other tool.

This dismembering and reassembling feature must be a very desirable and convenient one when it is desirable to use the forge in a place to which there is a restricted passage, or in taking it about from place to place.

The fan gives an excellent blast in whichever direction it is turned, and there is enough of the balance wheel feature about it—it is geared and turned by means of a crank, the gears and journals being encased to exclude dust—so that it will continue in motion longer than seems possible after the application of power has ceased, which will be appreciated in such work as heating and passing rivets. There are no frills about this—just a hand forge, and not a particularly handsome one at that, but I believe it is a good one.

Joseph Dixon is said to have invented the plumbago crucible in 1827, since which there has been a steady growth in the uses found for graphite. The Joseph Dixon Crucible Company, of Jersey City, N. J., has two exhibits, one in Manufacturers' Building, and the other in Mining Building. The pencil exhibit in the first named building occupies a space 10x14 feet, in the center of which is a low mahogany table surmounted by a pyramid of velvet, on which pencils in great variety are disposed by the hand of an artist. There is also a rosewood and plate glass exhibition case. The space is well lighted at night, and does credit to an article of manufacture which, if no more than 350 years old, has become indispensable. What surprised me most—for everybody knows a good deal about the Dixon pencils—was to learn that they were made in nearly one thousand varieties, and that last year the number made would, if so distributed, give to every man, woman and child in the United States nearly four pencils. Four times sixty-five millions of lead-pencils by one firm!

In the Mining Building the company's exhibit occupies a space of 25x28 feet, and embraces all articles manufactured by them into which graphite enters. Crucibles, retorts, ladles, boxes, incandescent filament forms, and a great variety of other products are shown in upright cabinets. In another is shown the development of an electrotype plate, in the process of which graphite is employed. In another case there are more than fifty varieties of graphite for as many different uses, such as for lubrication, foundry facings, stove polish, core wash, ingot wash, for hatters' use, for paint, and so on.

There are also shown samples of graphite from all the principal sources, one sample from the Island of Ceylon weighing 300 pounds.

One, unless quite familiar with the subject, cannot see this exhibit, finely arranged in every respect, without concluding that graphite plays a very important part in the industries of the world, probably much more so than he had before thought. H.

Experiments with the torpedo boat "Cushing" appear to indicate that it is possible to paint such boats so that their discovery in a dark night is very improbable. The "Cushing" cruised around two vessels that were looking out for her with their powerful search lights, aided by a search light on shore, approaching the vessels closely enough for all practical purposes without being detected.

Planing and Matching Machine for Hard Wood.

Owing to the fact that hard wood is usually rather unevenly sawn, and is further crooked and twisted out of shape in the process of kiln drying, it is difficult to dress it accurately in the machine, especially since the introduction of hard wood floors, wainscoting and interior finish has raised the requirements for this class of work. The accompanying illustrations are of a machine which has been designed especially for planing on both sides, and matching hard wood, and is a modification of a somewhat similar machine which has been for some time built by the manufacturers, J. S. Graham & Co., Rochester, N. Y.

It has been the practice in some establishments to use two machines and perform two separate operations upon hard wood matched stuff, the first operation being simply to secure one straight and true surface as a basis for the finishing operation. This machine is so designed as to bring about these results at a single operation.

It will be noticed that the machine has an extra under cutter, over which the lumber passes before being planed on the upper surface. This under cutter is preferably placed next to and in front of the top cutter head in order that the two pairs of feeding-in rolls shall give ample feeding power to the board while being dressed on the under side, and also to retain better control over the work.

The two under feeding rolls are arranged in connection with the receiving platen to raise and lower together, and provide for any desired amount of cut to be removed from the under surface, thereby insuring the cutting off of all bunches or projections, and finishing a straight surface on the under side which passes next over the bed-plate and under the top cutter head, thus providing a true and even surface while being acted upon by the top cutter head, and finishing a board of regular and even thickness. The side cutters then joint or tongue and groove, as desired, and finally the last under cutter takes a light finishing cut, giving an elegant, smooth finish, or it can be used for beading, etc. In this way the work is done not only in a satisfactory manner, but at a very rapid rate.

The first or special under cutter is fitted with a patent pressure device over the board, which at all times produces a pressure just where desired, whether the surfacing is done at one side or in the center of the machine. This is a feature of considerable importance and an actual requirement for superior work, especially on narrow boards.

The under cutter can be instantly drawn outside of the machine for convenience in adjusting, sharpening cutters, etc., as shown in smaller engraving. It is fitted with a shavings conductor, which takes care of all shavings and dust. This cylinder is also so arranged that it can readily be adjusted for height, and the entire machine possesses all the adjustments and improvements found useful for this class of work.

Fig. 1

Fig. 2

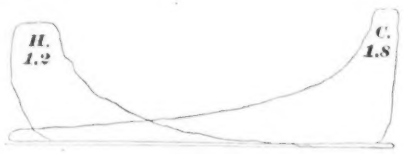


Fig. 3

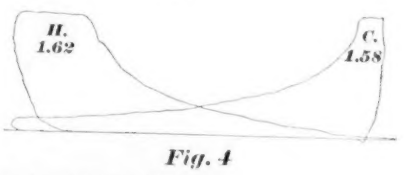


Fig. 4

Setting the Cut-off on an Automatic Engine.

Setting the Cut-off on an Automatic Engine.

By W. H. Wakeman.

Where the valves of an engine are perfectly tight, or nearly so, or even if they leak approximately the same amount, it is an easy matter to set the tripping mechanism so that the diagrams will have the same area, and do an equal share of work (ignoring the space occupied by the piston rod on one side), but having occasion to indicate an engine a short time ago, whose exhaust showed what is called "a long leg and a short leg," or in other words, gave one heavy puff and then a light one, I found the area of one card to be almost exactly two and one half times that of the other, as shown in Fig. 1. This was not due to an uneven cut-off as much as to a leak which had developed on one of the cut-off valves. One of the rods which connect the governor and the tripping device was shortened, and another pair of diagrams taken, which are shown in Fig. 2. In order to make sure that the diagrams showed the actual state of the valve gear, the governor was held rigidly while the diagrams were taken, thus insuring the same position of the balls for all the diagrams.

Here may be noted improvement, for while in Fig. 1 the areas were .85 and 2.12, in Fig. 2 they are 1.12 and 1.95 respectively.

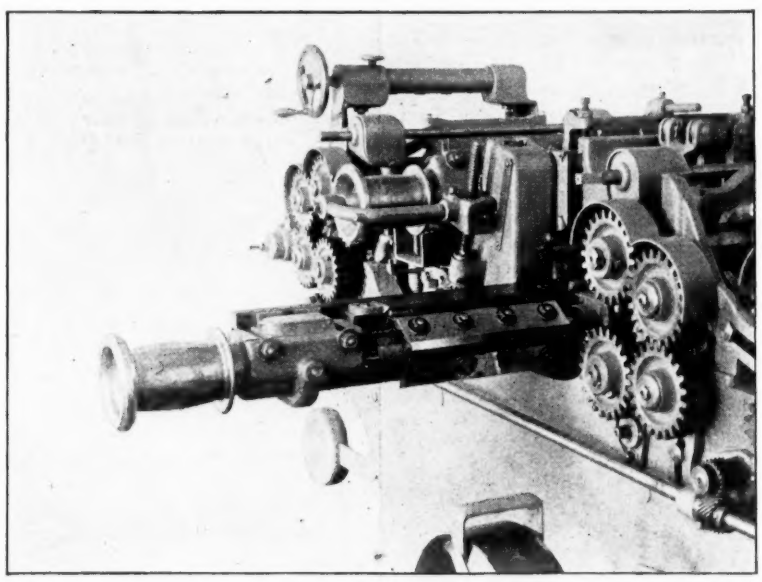
Fig. 3 shows a further improvement as the areas are 1.2 and 1.8, the rod leading to the crank end having been shortened.

Fig. 4 is better still, as the areas are 1.58 and 1.62.

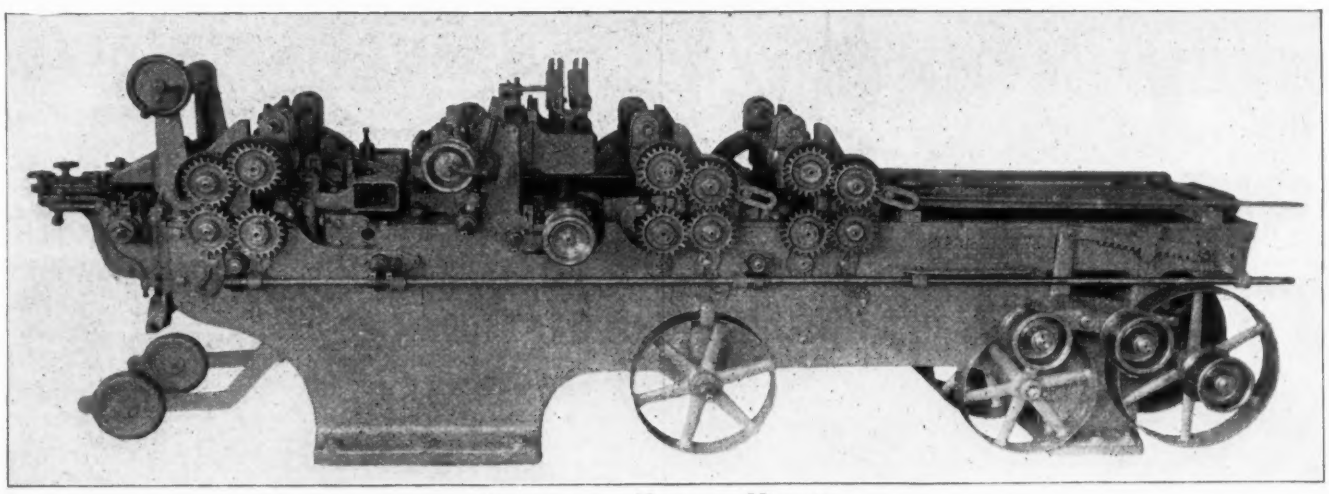
Of course, it is better to have tight valves and an even cut off, but if these are impossible for the present, it is better to even up the areas as above rather than to run as I found them.

Some engineers seem to think that if the puffs of exhaust steam are not all of the same size, the power developed on one stroke must be greater than that developed on the other. This is a rule which is not without its exception, as shown in this case, for although in Fig. 4 the areas of the diagrams are practically the same, still the puffs of exhaust steam were nearly as far from being alike as they were before the change was made. On second thought it will be plain why this is so, for the force with which the exhaust steam is expelled from the cylinder depends on the release pressure, or the terminal pressure, which are the same in many cases, and seldom vary but little in any one case. It will be noted that the terminal pressure on the crank end of Fig. 4 is nearly as great as in Fig. 1, and there is but little change in the terminal pressure of the head end, so that we could not expect much change on the exhaust puffs, but when the steam was exhausted from the crank end it came out with an effort at a puff, which died away in something resembling the long drawn sigh of a giant. This was due to a leak in the valve, for it must be remembered that the steam is making its way into the cylinder during the return as well as the forward stroke. The main belt of this engine was long and not very tight, consequently before the valves were set it did not run steadily, but after the load was evenly distributed a great improvement was apparent, for it kept its place as nicely as any one could wish. This calls attention to the fact that if the main belt does not run steadily, it should not be tightened up until it is known that the valves are set correctly.

Setting the Cut-off on an Automatic Engine.



Planing and Matching Machine.



The Mechanical Value of War.

By W. D. Forbes.

There has been considerable said of late concerning a Peace Congress, and some very remarkable statements have appeared in the daily press as coming from it, which, if correctly reported, go to prove that the supply of fools has not run out yet.

The writer being interested in firearms for the extermination of his fellow men, has given the subject much study, and, broadly speaking, he is of the opinion that civilization is about all due to war, and the present state of mechanics is the result of the human desire to kill somebody or something.

Undoubtedly a club was the first weapon, and when the stronger man knocked the heads of his weaker fellows, some weaker fellow probably set about trying to equalize matters by sharpening a long stick to jab the life out of the stronger brother out of reach of his club.

Some friends try to make the writer believe that weapons were first used for obtaining food; that the original man hunted his dinner before he hunted his fellow man. The experience of the writer among savage tribes does not bear out this idea, and as none of these friends had ever been the "huntee," he cannot accept the idea as he can his own practical knowledge.

The most ancient piece of fine workmanship in metal ever seen by the writer was a dagger, which must have been made to stick into people, as its shape made it of very little use for any other purpose, and the next piece of work made much later, but of exquisite workmanship, was a shirt of mail, made to keep its wearer from being stuck by a dagger.

How the shirt was made is a puzzle. It was made up of rings perhaps $\frac{1}{2}$" inside diameter, and say $\frac{1}{16}$" wire, and each ring had a band of gold let into it which went entirely around. No hammer marks could be seen, and the surfaces, where not rusted, were perfectly polished.

Long before they made the sewing machine, firearms had been made on the same plan which allows sewing machines to go into every house, and, so far as the writer can find out, the interchangeable system was the result of a desire on the part of the people of the United States to kill people with arms of superior quality at a small price, and the results have been most satisfactory to the world at large.

To-day we do not hunt each other with

the idea of speedily taking life, but we hunt each other commercially to starve our fellow men to such an extent that they will grow tired of trying to live by the means we take of obtaining food and clothes, and retire from our love of business.

This results just as did the battles of old, in the survival of the strongest, not always the fittest, and the result to the general world is good, since no man can make his rival move off unless he offers better or cheaper ware, or both to the world.

This does not sound nice, and some may shake their heads and say I do not want to have my fellow machinist go to the wall—I want him to make a living. True enough, but if the fellow machinist gets into the way of taking work thought to be the right of the kind hearted machinist, there will be a shift of views; the head shaker will do as the good people of Canterbury, Conn., did in the fifties, when Miss Crandall started a colored school there. They waited on her, and said that they thought the darkies should be educated, ought to be taught, but not in the town of Canterbury, and to their shame, be it said, they drove Miss Crandall out of town by force. Few of us have not felt the strain of the past three months, and few of us have not had to cut down expenses to turn and twist to get work to keep things running, but uncomfortable as it has been and still is, the trial will do good, as did the blows of the soldiers of old, the sturdy survive, and self-protection will be learned.

There seems to be a belief among shop managers that what is done in our own shop, if a little more expensive, is not far from others as to cost, and away up in quality. One sees this in a jobbing shop, as customers are constantly saying this or that operation costs more or less than in the shop where the work was last done.

The writer being interested in boring holes in cylinders, etc., was staggered when he found a shop could bore a good, true hole 4½″ diameter and 5″ long for three cents, while he could not do the work for five times the sum. Of course an allowance must be made for the fact of large numbers in one case and small numbers in the other, yet it sets one to thinking when another can so thoroughly out-class him in any work. Returning to the question of war. It is fair to suppose that the fine polish and beautiful finish so often seen in old arms as weapons of war, came by the condition of the soldier not always being engaged in killing people, and in his leisure moments he started in to polish up his weapon, until the condition of a fine finish was demanded of the maker. At any rate, it is to-day demanded that we kill our enemies with arms which are as finely finished as a watch, and in this demand can be shown work for hundreds who, in executing it, obtain support for long years, while the misery our peace friends see in war is comparatively of short duration.

Aluminum Boat.

A boat constructed of aluminum and intended for the forthcoming expedition of Commander Monteil into Central Africa, has just been launched from the Quay d'Orsay, in Paris. It is a flat-bottomed ferryboat, capable of carrying a load of 15 tons, is 33 feet long and 8½ feet wide, and the total weight of the boat is 20½ cwt., of which 18 cwt. is of metal and the remainder of wood. This lightness of construction has only been obtained by the use of aluminum, and the difficulty had to be overcome of rolling sheets of this metal 4 feet long, 2 feet 4 inches in width, and 0.12 inch thick. The boat is made in twenty-four parts, each of which can be carried by one man, and which are adjusted by means of bolts; india rubber being provided at the joints of the sections so as to render the boat water-tight. With two exceptions all the parts are interchangeable, and the boat, which is fitted with the tools necessary for assembling it, can be put together in a very short time.—*The Mechanical World.*

A St. Louis dispatch says: The once great Vulcan Iron Works, built at a cost of $1,000,000 and covering six acres of ground, are being sold piecemeal as junk. The eight-ton steam hammer was sold to Pittsburgh manufacturers yesterday for $6,000. Even the brick-work is disposed of to wreckers. When in operation the works employed 2,800 men, but its machinery was not up to modern standards, and the big strike of 1882 ended its active career.

The latest idea in transportation comes from England, and is nothing more or less than our familiar roller skates, provided with pneumatic tires, which, it is claimed, adapt them to use on ordinary roads. The rollers are about 3½″ diameter, are provided with ball bearings and run noiselessly, though the speed attained is said to be about equal to that of the cycle, while of course the first cost and repair bills are much lower.

The most powerful hydraulic crane at present existing is reported to be one at the Italian Government Arsenal at La Spezzia. It is capable of lifting 160 tons, or 10 tons more than the large electric crane at the Creusôt Works.

MANUFACTURES.

C. W. Miller will start a shoe factory at Waynesville, N. C.

The Gould Car Coupler Works at Depew, N. Y., will start soon.

The Nova Scotia Steel and Forge Co., New Glasgow, N. S., is making additions.

The Caldwell Machine Co., Richmond, Va., will erect a new plant costing $100,000.

W. L. Grant & Sons will rebuild their burned wood working and machine shops at White Plains, Ga.

The Penn Hardware Works, Reading, Pa., employing 500 hands, have resumed operations on full time.

The plate-mill of the Ellis & Lessig Iron and Steel Company at Pottstown, Pa., resumed operations October 10.

The Springfield (Ill.) Boiler and Manufacturing Company will increase its capital stock from $78,000 to $178,000.

Debs Publishing Co., Terre Haute, Ind., issue a catalogue—sent free—of engineering books published and sold by them.

The puddling department of the Clinton Iron and Steel Company resumed work October 10 after an idleness of several months.

Fraser & Chalmers, of Chicago, Ill., have issued a small pamphlet descriptive of the Riedler pumping machinery which they build.

The Midland Manufacturing Company, of Topeka, Kan., is adding a brass foundry to its works, beside making additions and improvements.

William Gardam & Son, 98 John street, have issued a circular illustrating and describing the sensitive drill shown in our issue of September 28th.

Nearly all of the men who were laid off during the financial depression have returned to work in the Atchison, Topeka & Sante Fe machine shops.

The Bellemonte Silk-mill at Hawley, Pa., employing 500 hands, working two days a week the past five months, commenced work on full time October 9.

The addition to their machine shops now about completed by the George V. Cresson Co., of Philadelphia, is 108x250 feet, and some of the equipment is now in place.

The Bennett Mfg. Co., 1510 Chestnut street, Philadelphia, Pa., have issued their initial catalogue of engineers', draftsmen's and architects' instruments and supplies.

Henry Warden is building a large factory building of brick adjoining his boiler works at Germantown Junction, Philadelphia, which will be leased with power to manufacturers

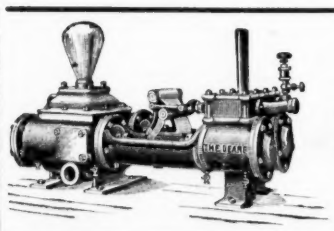
Dexter, Lambert & Co.'s silk factory at Honesdale, Pa., which laid off a number of hands and reduced working hours two months ago, have resumed full time with all hands.

The puddling and the iron and steel rail departments of the Bethlehem Iron Works, Bethlehem, Pa., resumed work Monday. They have been idle several months. Fifteen hundred men will be given work.

The Anderson Steel Casting Co., of Anderson, Ind., has opened a branch office at 506 *Inter-Ocean* Building, Chicago. Mr. J. A. Kurtz, vice-president of the company, will have his headquarters at that place.

The Lodge & Davis Machine Tool Co., of Cincinnati, O., have just received a large order from the Big Four Railroad for lathes, etc., to be used in the new shops of that company now in course of construction at Bellefontaine, O.

The puddle-mill of the Phœnix Iron Company, Phœnixville, Pa., resumed operations October 10.



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OF HOLYOKE
STEAM PUMPS
DEANE STEAM PUMP CO.,
HOLYOKE, MASS.

CRESCENT STEEL CO.
PITTSBURG, CHICAGO, NEW YORK.
STEEL FOR Lathe and Planer TOOLS, Cold Chisels, Punches & Dies, Milling Cutters, Molding Bits, &c.
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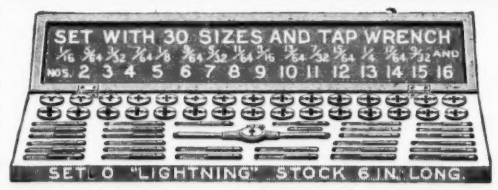

"Lightning" Screw Plates
For Machinists, Electricians, Bicycle Repairers, &c. Adjustable Dies with Guides.
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GREENFIELD, MASS.

"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
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BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

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Manufacturers of Foot and Power
ENGINE AND SPEED LATHES,
For General Machine and Jobbing Shop, Electrical and Experimental Work.
DEALERS IN MACHINISTS' TOOLS AND SUPPLIES.

DYNAMOMETERS AND THE MEASUREMENT OF POWER.
By J. J. FLATHER,
12mo, cloth, illustrated, 221 pages, $2.00.
JOHN WILEY & SONS,
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GRANT GEARS
Ready Made Cut Gears.
Ready Made Cast Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
Gear Book, 15 cents.
Treatise on Gears, $1.00.
Gear Cutting Machines.
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Lexington, Mass.,
and 125 South 11th St.,
Philadelphia, Pa.

Pat. KEY-SEAT SETTING GAUGE
PATENT UNIVERSAL DEPTH ANGLE AND SCREW-CUTTING CENTER TWIST DRILL GAUGE
J. WYKE & CO. Fine Machinists' Tools. E. Boston, Mass. Send for LISTS

Improved Lead Fillet for Pattern Makers.
SAMPLES FREE.

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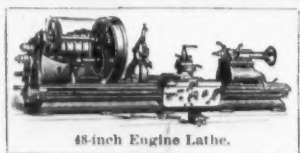
Sole Manufacturer,
44 North 4th St.,
PHILADELPHIA, PA.

FITCHBURG MACHINE WORKS,
MANUFACTURERS OF THE CELEBRATED
FITCHBURG MODERN ENGINE LATHE
AND OTHER METAL-WORKING MACHINES
SEND FOR CATALOGUE E.

48-inch Engine Lathe.
FITCHBURG, MASS.

H. W. JOHNS'

ASBESTOS SECTIONAL PIPE COVERINGS.
NON-CONDUCTING COVERINGS FOR STEAM AND HOT WATER PIPES, BOILERS, ETC.
ASBESTOS BOILER COVERINGS.
H. W. JOHNS MANUFACTURING COMPANY,
H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.
87 MAIDEN LANE, N. Y. JERSEY CITY, CHICAGO, PHILADELPHIA, BOSTON, LONDON

giving employment to a large number of hands after a long idleness. The entire plant, it is believed, will soon be in operation.

The Standard Smokeless Furnace Company, of East St. Louis, Ill., has been chartered, with a capital stock of $150,000, for the manufacture of furnaces, stokers, etc. Percy B. Weston, W. B. Farr and others are the incorporators.

The W. H. Page Boiler Co., Norwich, Conn., have had plans made for a new foundry which they propose to build in connection with their plant on Franklin street. This is to be done to accommodate their large and increasing business.

The New Home Sewing Machine Co., at Orange, Mass., have placed the contract with the Berlin Iron Bridge Co., of East Berlin, Conn., for a new foundry and tumbling room. The building will be entirely of iron, 45 feet in width and 120 feet in length.

The Everett and the Pemberton mills, Lawrence, Mass., have started up in full. They have been shut down for more than a month. A portion of the Arlington cotton-mills in that city has also started. The Pacific mills are running on full time.

The 1,000 employes of the Lambert & Bishop wire-mill at Joliet, a branch of the Consolidated Wire and Steel Company, were recently surprised to read the official announcement that the entire plant would resume work. This mill has been shut down for the past six months.

The H. R. Barker Manufacturing Company, 190 Middle street, Lowell, Mass., has issued an illustrated catalogue devoted to a description of the Richmond steam and hot-water heaters made by the Richmond Stove Company, of Norwich, Conn., radiators, etc., and supplemented with a list of references in Lowell and vicinity.

A contract has been signed by which Fulton, Ill., gets the Pennsylvania cotton-mills of Allegheny City, Pa., giving five acres of ground for the plant and $40,000 bonus. Seven buildings will at once be erected and eighty-four carloads of machinery will arrive soon. The plant will give employment to 750 men.

The recent purchase of 3,000 acres of land at Ashtabula, O., the iron ore receiving port, was made by the Rockefellers, and a steel plant is to be erected, ground having been broken for a portion of the works. It is said the Rockefellers propose to make a fight for supremacy against Carnegie and the Illinois Steel Company. They contemplate a product of 2,000 tons of steel a day.

The Hendey Machine Co., of Torrington, Conn., has issued a pamphlet (standard size 6"x9") which relates solely to the Hendey-Norton lathe, which is fully illustrated and described by perspective and detail engravings. Engravings are given also of specimens of lathe work made in the Hendey shops upon the Norton-Hendey and upon the ordinary lathe by the same man, the difference in time being given. It is a pamphlet which will interest all who have to do with lathe work and will be sent on application.

The *Commercial Bulletin* has account of the following concerns that have recently started up: The Roanoke (Va.) Machine Works; the Duvall Engine Works, of Roanoke, Va.; the stove works of Gibson & Love, Chattanooga, Tenn.; the Penn Hardware Works, of Reading, Pa.; the Farrel Foundry and Machine Co., Ansonia, Conn.; the Dexter Tool Co., of Bangor, Me.; the Norton & Jones Machine Tool Works, Plainville, Conn.; the Titusville (Pa.) Iron Works; the Seibel-Suessdorf Copper and Sheet-iron Manufacturing Co., of St. Louis, Mo.; the Union Hardware Co., of Torrington, Conn.

Machinists' Supplies and Iron.

NEW YORK, October 14, 1893.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $14.50 to $15.00; No. 2, $13.50 to $14.25; Gray Forge, $12.25 to $12.50. Southern brands of good quality are obtainable at $13.75 to $14.50 for No. 1 Foundry; $12.50 to $13.50 for No. 2, and $11.75 to $12.50 for Gray Forge.

Antimony—The market is steady at a decline. We quote L. X., 9⅞c.; Cookson's, 10⅛c. to 10¼c.; Hallett's, 9.65c. to 9.70c., and U. S. French Star, 10c.

Lard Oil—Prime City is quoted at 75c. to 76c.

Copper—The market is dull. For Lake Copper 9⅞c. is asked by Lake companies, but it is claimed that second dealers may sell for a shade less. Casting Copper is held at 9¼c. to 9.40c.

Lead—The market has a downward tendency; 3.40c. is asked, but actual business might be done at 3.45c.

Spelter—The market is weaker with offerings at 3.55c. for prompt shipment from primary sources, and 3.6°c. for New York delivery.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

First-class draftsman and M. E. wants position. Box 111, AMERICAN MACHINIST.

Wanted—Pos. as ass't mech. d'f'sman exp'd; good refs.; grad. mech. arts. M., Box 120, Foxboro, Mass.

Mech. draftsman, graduated in Germany, wants a position. Care of Rode, 40 Union Park, Boston.

Draftsman (designer) experienced on mach. tools, jigs, fixtures and gen'l mach'y desires position. Box 76, AMERICAN MACHINIST.

Wanted—Position as foreman or assist. foreman in mach. works; 21 yrs. exp.; age 38; steam pumps preferred. Address R. K., Box 115, AM. MACHINIST.

Wanted—Position as draftsman by young man with 3 years' experience; technical education and shop practice; moderate salary. Box 46, AM. MACH.

Tool maker, years of experience milling cutters, reamers, dies, all machine and boiler tools, wants position. Address City, care AM. MACHINIST.

Wanted—Situation by a first-class all-round machinist, sober and reliable; general repair work, tool making, etc. Box 114, AMERICAN MACHINIST.

Wanted—Thoroughly competent foreman for established job foundry who can invest $5,000 in the business; foundry equipped with all modern improvements. Address A. P. H., AM. MACHINIST.

A young man who has worked from apprentice to superintendent, with no influence except ability and attention to business, is thoroughly practical; expert on Corliss engines and heavy machinery, desires situation. Box 113, AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Draftsmen's new comb. triangles, etc.; cir. free; small sample, 10c. D. J. Kelsey, New Haven, Conn.

Drawings made of jigs, fixtures, special tools and devices to work in best possible manner. Address Box 62, Providence, R. I.

For sale—One 36" Brainard Automatic Gear Cutter; one 36"x36"x12' Pease Planer; one 32"x10, Lodge-Davis Standard Engine Lathe with raising blocks to swing 40". These tools have only been in use one year; will be sold low for cash. The Fosdick & Plucker Machine Tool Co., 142 Culvert Street, Cincinnati, O.

"Threads and Gears" is a work by G. W. Dixon, just published, on the change gears of the lathe on cutting screw threads; the rules are simple and plain; there is no algebra in the rules, and will give the correct gears to cut any thread that can be cut; sent to any address on receipt of price, 50c. G. W. Dixon, Spring Lake, Mich.

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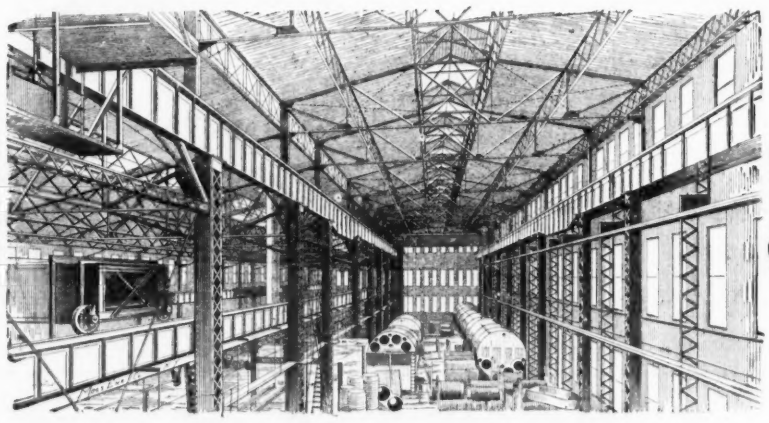
INSIST ON HAVING
NICHOLSON.

NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.

3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of

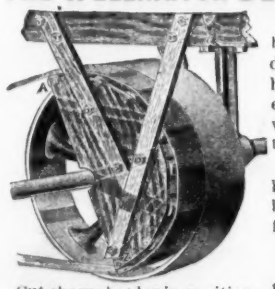


Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph and shows the interior of a Boiler Shop designed and built by us for Wm. Cramp & Sons' Ship and Engine Building Co., at Philadelphia, Penn. The Boiler Shop portion of the building is 55 feet in width and 370 feet in length. The adjacent Blacksmith Shop (shown on the left) is 59 feet in width and 350 feet in length. The Boiler Shop is 50 feet in height with a 50 ton traveling crane. The building is covered on the sides and roof with Corrugated Iron.

SEND FOR OUR ILLUSTRATED CATALOGUE.

THE WELLINGTON BELT HOLDER.



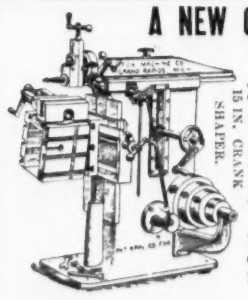
Large or small belts shifted from driving pulley and held at rest, and easily slipped back when machine is to be started.
It dispenses with loose pulleys, saves belts, and is perfectly safe.
It is *cheap*.
Write for descriptive circular and price list to

Cut shows holder in position beside driving pulley.

COOKE & CO.,
163 & 165 WASHINGTON STREET, NEW YORK.
And mention American Machinist.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

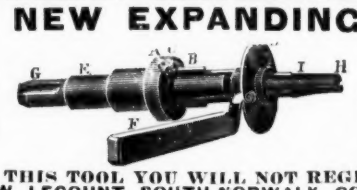
A NEW CRANK SHAPER.



NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co,
325 NOR. FRONT ST.,
Grand Rapids, Mich.
Chicago Office, Machinery Hall Annex, Section 13, Column J 43, World's Columbian Exposition.
135 Finsbury Pavement, London, England.

LECOUNT'S NEW EXPANDING MANDREL.

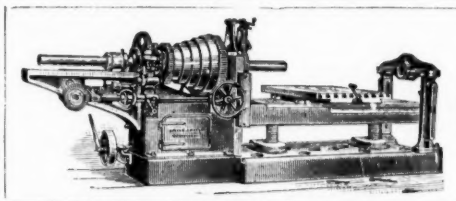
Amateur's Size.
Taking anything from ⅛ to 1 inch inclusive.
Price.....$5.00
Patented Dec. 25, 1877.



Machinist's Size.

No.			Price.
1	⅛ to 1	in.	$10
2	1 "	1½ "	14
3	1½ "	2 "	18
4 (with screws)	2 "	3 "	32
5 " "	3 "	4 "	44

IF YOU WILL TRY THIS TOOL YOU WILL NOT REGRET THE EXPENSE.
C. W. LECOUNT, SOUTH NORWALK, CONN.
SPECIAL MANDRELS FOR SPECIAL JOBS MADE TO ORDER.
These goods are for sale by CHAS. CHURCHILL & CO., L'td., 21 Cross St., London, England.



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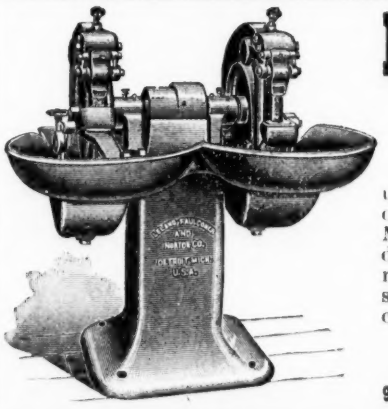
WILMINGTON, DEL.
MACHINE TOOL BUILDERS.
IMPROVED PATTERNS! LATE DESIGNS!
Chicago Office: 14 South Canal St.



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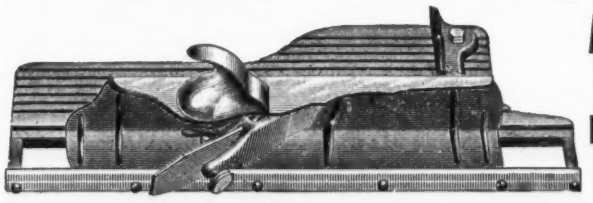
WET EMERY GRINDER.
Any amount of water easily applied without the use of Pump, Hose, Treadles, Cocks, or any of the objectionable features common in this class of Machine. Truing Device, which is inexpensive, does the work perfectly and quickly. The whole rig practically as simple as the old-fashioned grindstone trough and much more effective. Send for circular.
LELAND, FAULCONER & NORTON CO.,
96 TO 106 BATES STREET, DETROIT, MICH.

PATTERN MAKERS' SHOOT PLANE & JACK BOARD.

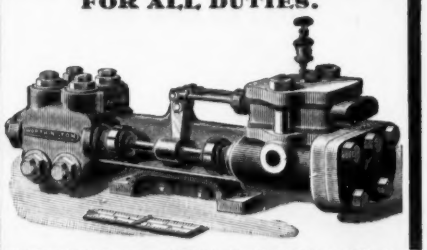


A. J. WILKINSON & CO.
180 to 188 WASHINGTON ST.,
BOSTON, MASS.
SEND FOR CIRCULAR.

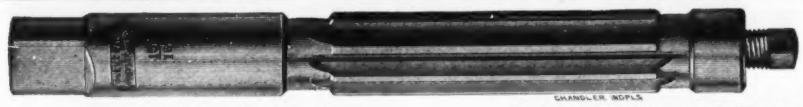
"Star" Foot Lathe Swings 9x25 in.
LATHE
Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes, Mortisers.
Catalogue Free of all our Machinery.
Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y.

JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LD.
Established a century ago.

WORTHINGTON STEAM PUMPS
FOR ALL DUTIES.



HENRY R. WORTHINGTON,
NEW YORK,
BOSTON, PHILADELPHIA, CHICAGO,
ST. LOUIS, DENVER.



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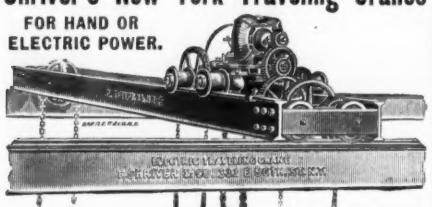
CLEVELAND TWIST DRILL CO.
Corner Lake & Kirtland Sts., Cleveland, O.
100 & 102 Reade Street, New York.
85 Queen Victoria St., London, Eng.

Shriver's New York Traveling Cranes
FOR HAND OR ELECTRIC POWER.



T. Shriver & Co. 333 East 56th St., NEW YORK.
MANUFACTURERS OF
TRAVELING CRANES of 1½, 2, 3, 5 and 10 Tons capacity, to be operated by Hand, or **wholly** or **in part** by Electricity.

SOFT CASTINGS,
Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.
THE BURR & HOUSTON CO.,
33 TO 39 FRANKLIN ST., BROOKLYN, N. Y.

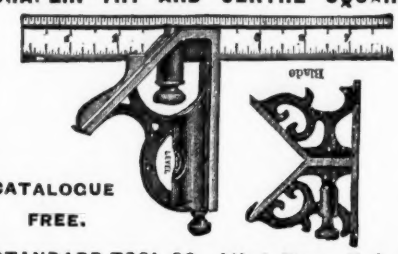
MACHINE SHOP OUTFIT
Modern Tools—A 1 Order—Low Prices.

Improved Lathe, 13 in. x 6 ft., Cpd. Rest, Cross-feed, Hollow Spindle.
Flather Lathe, 16 in. x 6 ft., Taper Attch'mt, Hollow Spindle 1⅞ in. and Un'v'sl Chuck. Good as new.
Hendey Lathe, 18 in. x 10 ft., Cpd. Rest, Cross-feed, Hollow Spindle and Chuck. Good as new.
Rowland Lathe, 20 in. x 8 ft., extra heavy Cross-feed and Chuck
Blaisdell Lathe, 22 in. x 20½ ft., (raising blocks 30 in.) Compound Rest, Cross feed and Chuck.
Putnam Lathe, 24 in. x 12 ft., Compound Rest, Cross-feed and Chuck. Good as new.
New Haven Planer, 20 in. x 4 ft. Complete.
Freeland " 24 in. x 8 ft. "
Powell " 30 in. x 10 ft. "
Prentice Shaper, 12 in. Stroke, Crank Motion.
Hendey " 15 in. " Friction.
Improved " 15 in. " Crank Motion.
Blaisdell Drill, 20 in., Wheel Feed.
Ames " 24 in., Bk. Gears and Aut'mtc Feed.
Radial " 6 ft. Arm.
Garvin No. 1 Screw Machine, with Wire Feed.
Brown & Sharpe No. 5 Screw Mch., with Chasing bar.
Niles Tool Works Screw Machine, 1¾ in. hole, with Carriage, Turret Feed, Chuck and Tools.
Upright Boring and Turning Mill, 38 in.
Brown & Sharpe No. 2 Turret Mkg. Machine, 36 in.
Lincoln Milling Machine, with Vise.
Universal Milling Machine, "Improved Style."
Boiler Bending Rolls, "Improved Style," 8 ft.—Hinged Housing.

J. J. McCABE,
SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.
14 Dey St.,
NEW YORK.

GRAY IRON
CASTINGS
Machinery Castings from small to 10 tons each. Modern practice and facilities. Pickled or rattled. Capacity 20 tons daily. Send for Estimates. Guaranteed delivery. Write us.
THE SPRINGFIELD MACHINE TOOL CO.,
SPRINGFIELD, OHIO.

CHAPLIN TRY AND CENTRE SQUARE.



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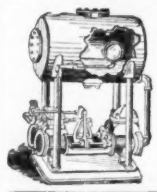
STANDARD TOOL CO., Athol, Mass., U. S. A.
Manufacturers of MACHINISTS' FINE TOOLS.

WE ARE OFFERING
BARGAINS
from the Equipment of the **United Electric Traction Co.'s Works,** of Marion, N. J., comprising
Engine Lathes, from 14" to 48" swing.
Hand Lathes, from 10" to 20" swing.
Planers, from 24"x5' to 42"x12'.
Shapers, from 15" to 20" stroke.
Drill Presses, all sizes up to 24" swing.
Milling Machines, Plain and Universal.
Brown & Sharpe Screw Machines.
1 Large Newton Slotting Machine.
1 Large Pond Mach. Tool Co.'s Radial Drill Press.
3 Gould & Eberhardt Automatic Gear Cutters, 36", 48", and 60".
1 Betts Machine Co. large Horizontal Boring Mill.
2 Large Bliss Power Presses.
1 10 H. P. Baxter Engine, with 45 H. P. Boiler, complete, as good as new.
Also, Tool Grinders, Die Sinkers, Tapping Machines, Bolt Cutters, and large Pattern and Blacksmith Shop Equipments.
These tools are in good order and of the very best makes in this country. They will be sold at remarkably low prices
Call at our salesroom and inspect them, or write for complete descriptive circular and price list.
THE GARVIN MACHINE CO.,
LAIGHT & CANAL STS., NEW YORK.

IF YOU WANT ANYTHING IN THE LINE OF
DROP PRESSES · DROP HAMMERS · STAMPS OR AUTOMATIC DROP LIFTERS.
SEND FOR CATALOGUE TO
Miner & Peck Mfg. Co.
NEW HAVEN, CONN.
LARGEST LINE IN THE MARKET



AUTOMATIC FEED PUMPS AND RECEIVERS
For returning hot condensed water to boiler.
STEAM PUMPS FOR ALL DUTIES.
THE BUFFALO STEAM PUMP CO.,
WORKS, BUFFALO, N. Y.
BRANCH OFFICES { 76 JOHN STREET, N. Y. CITY
55-57 CLINTON STREET, CHICAGO, ILLS.

GRAHAM TWIST DRILL AND CHUCK CO., DETROIT, MICH., U. S. A.
SOLE MANUFACTURERS OF
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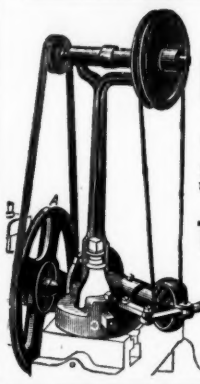

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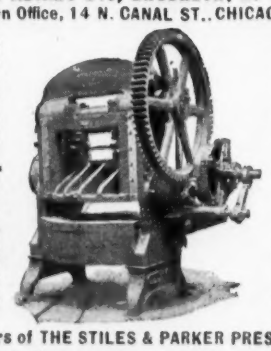

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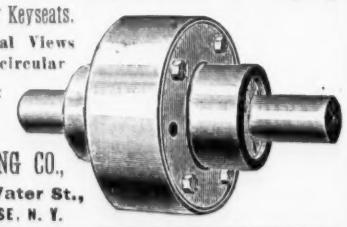

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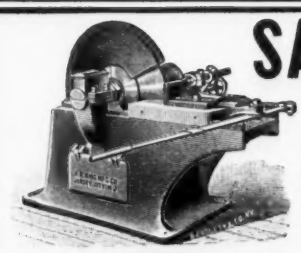

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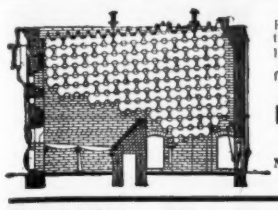

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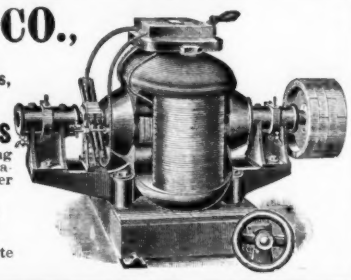

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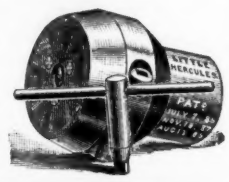

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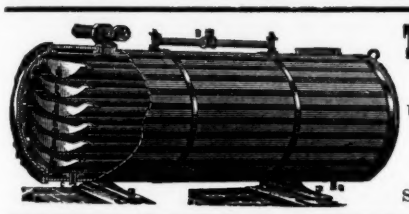

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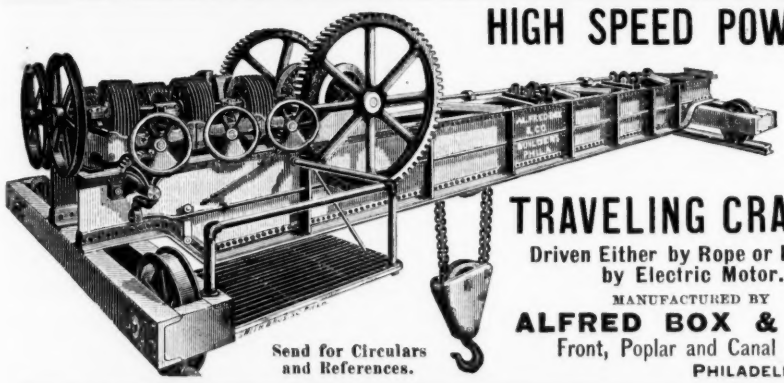

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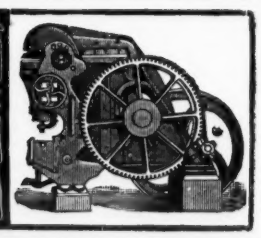

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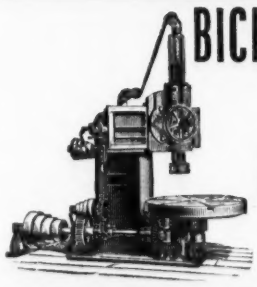

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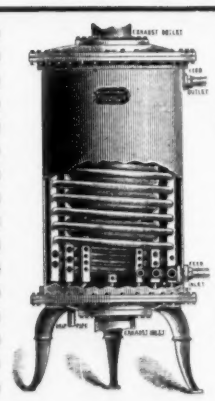

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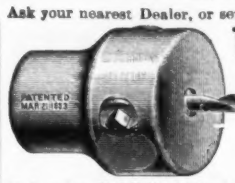

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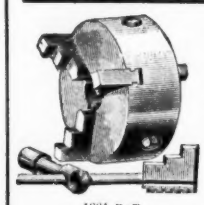

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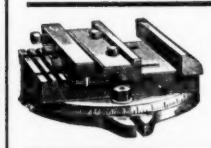

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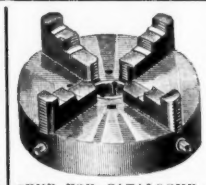

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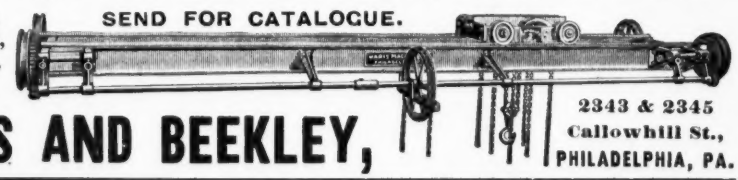

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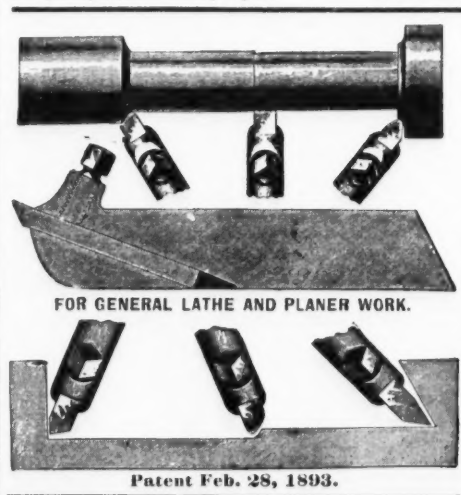

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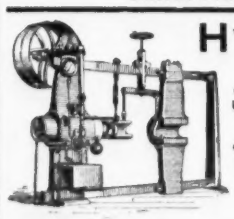

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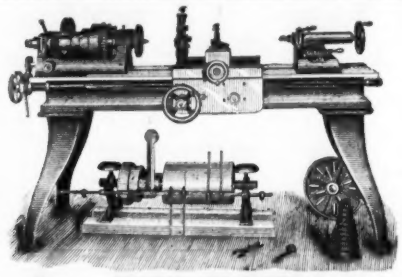

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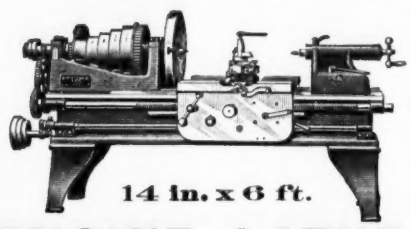

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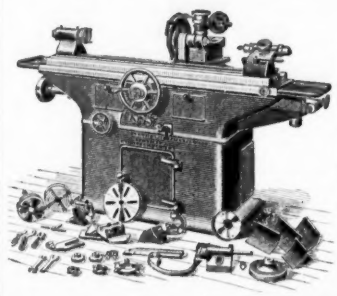

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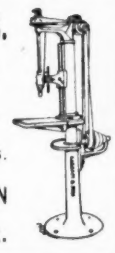

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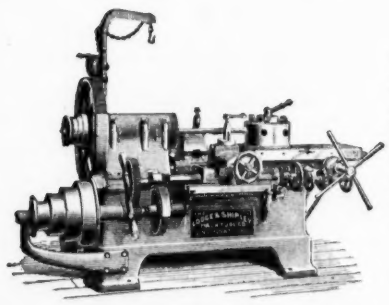

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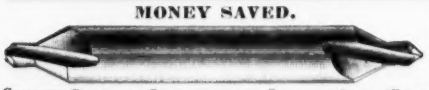

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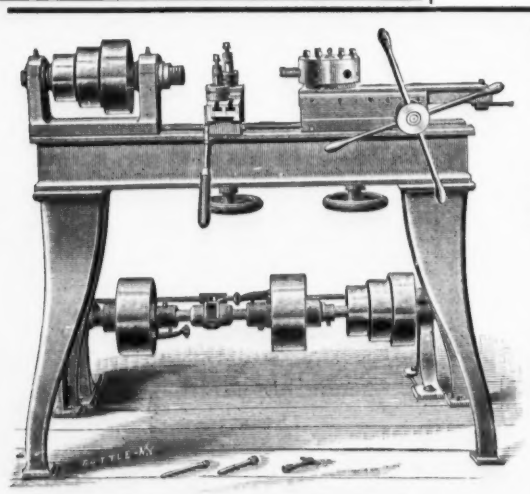

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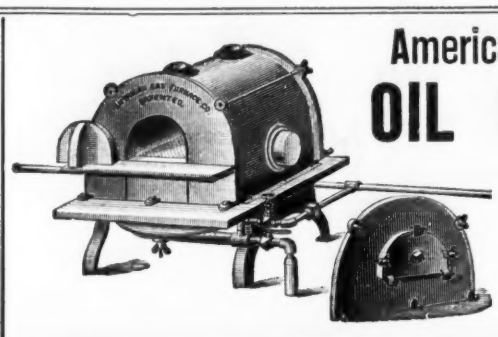

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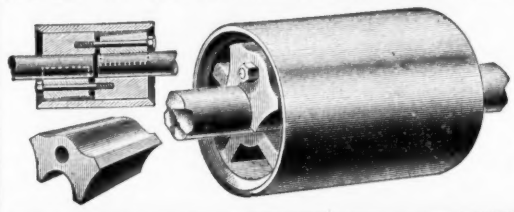

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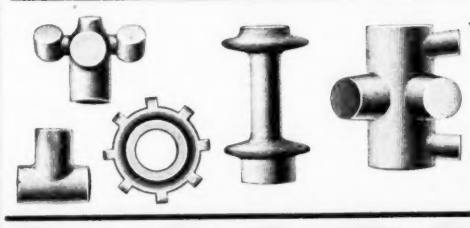

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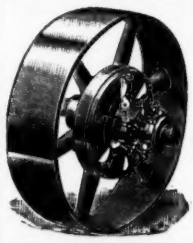

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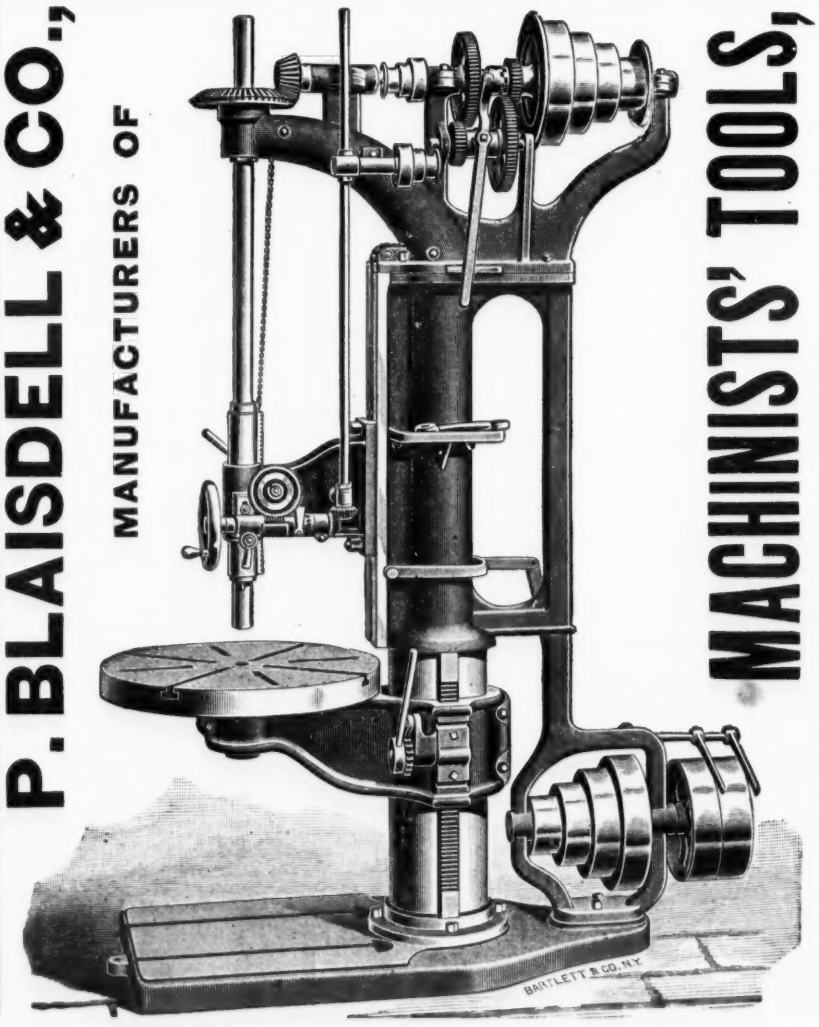

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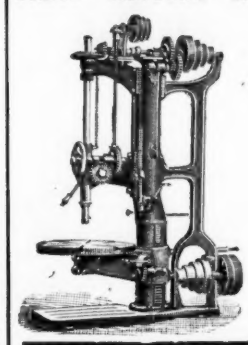

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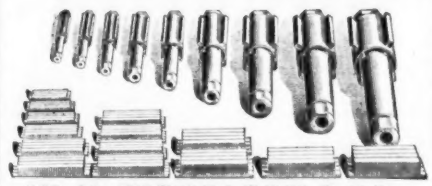

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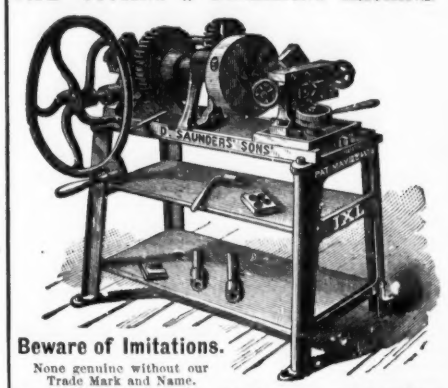

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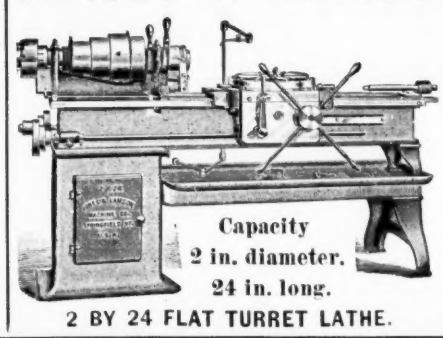

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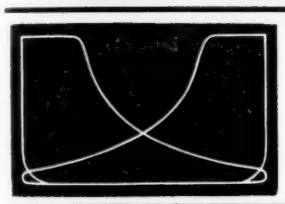

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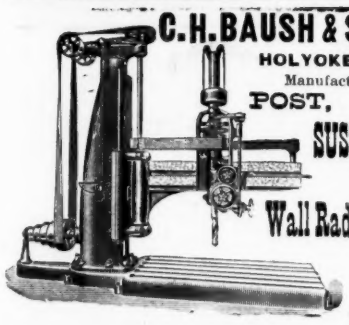

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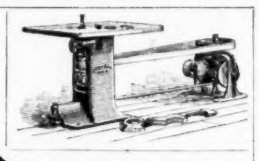

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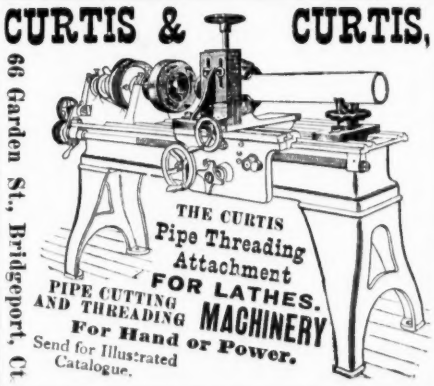

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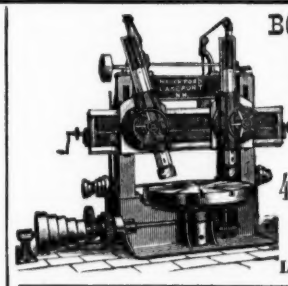

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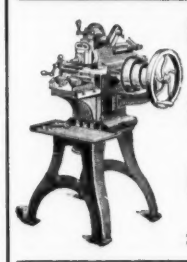

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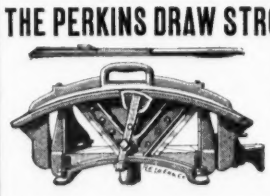

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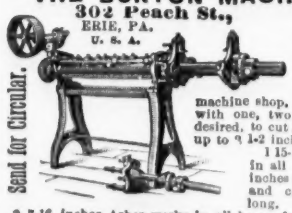

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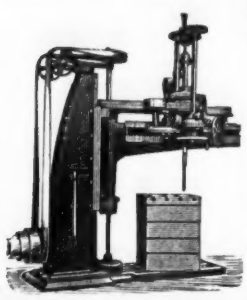

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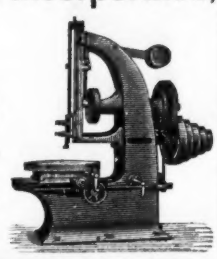

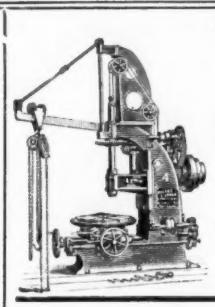

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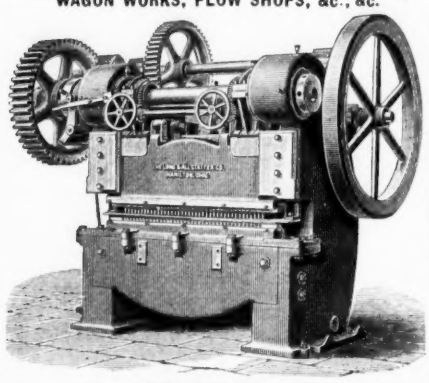

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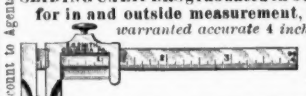

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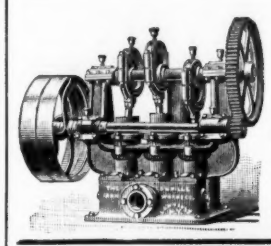

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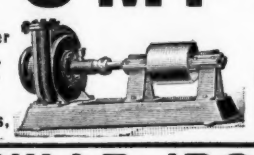

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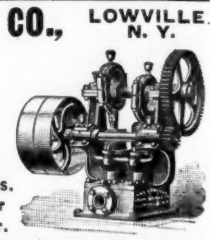

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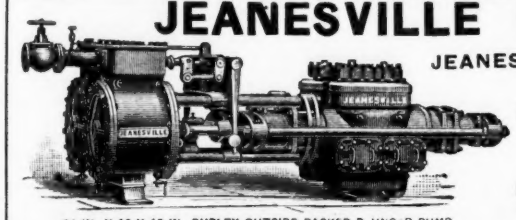

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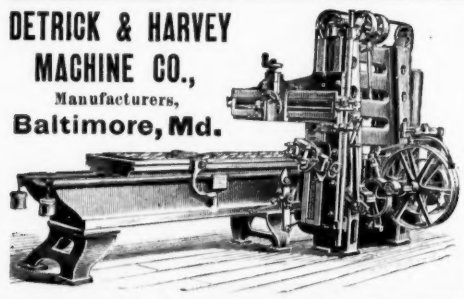

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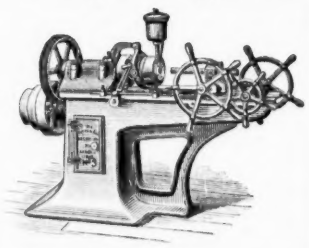

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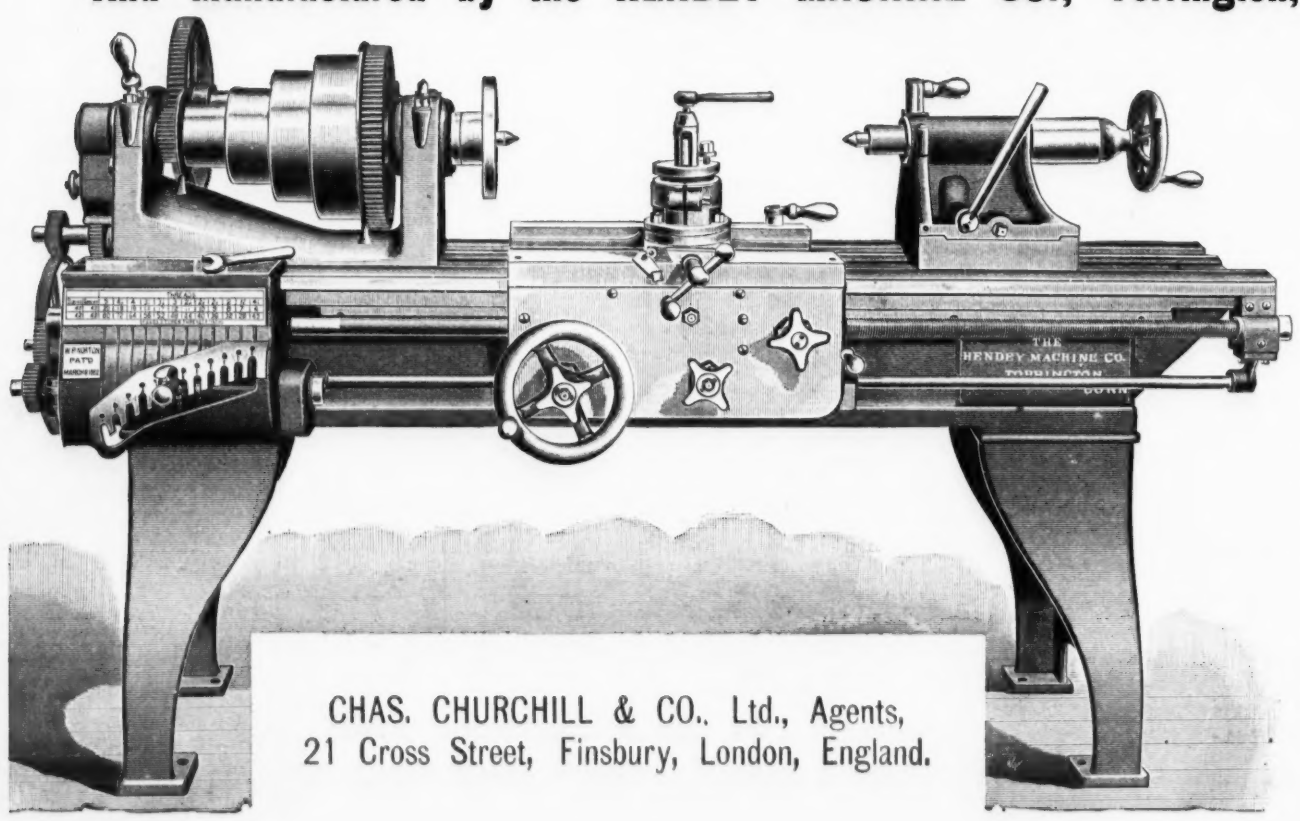

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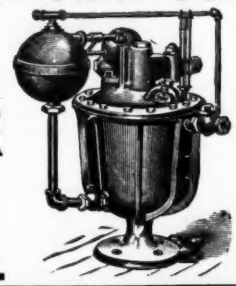

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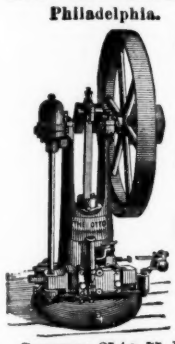

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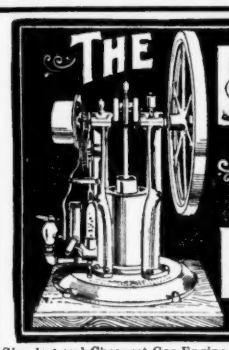

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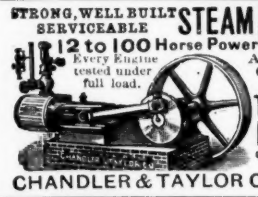

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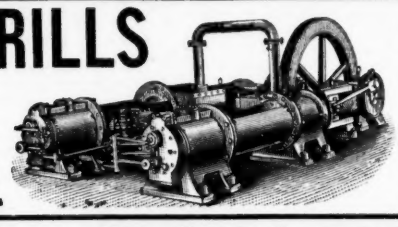

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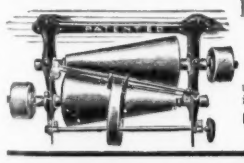

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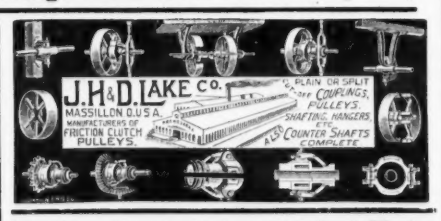
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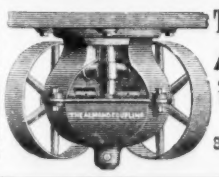

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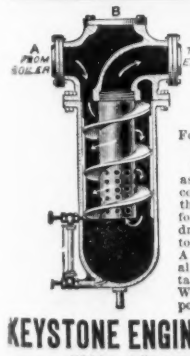

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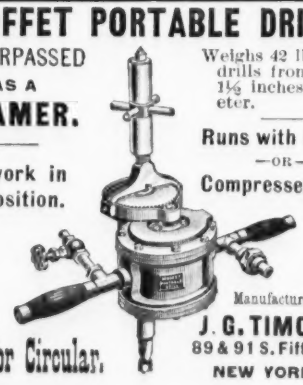

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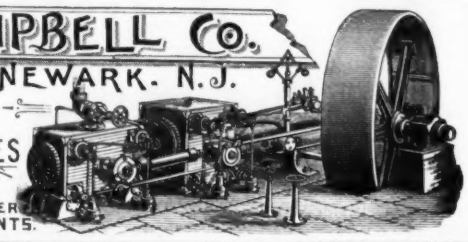

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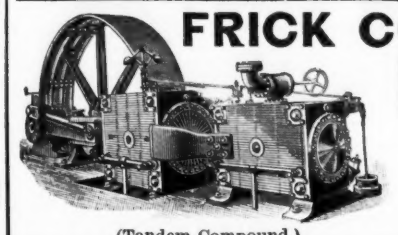

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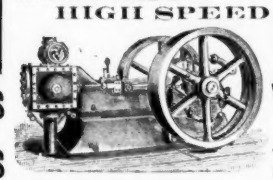

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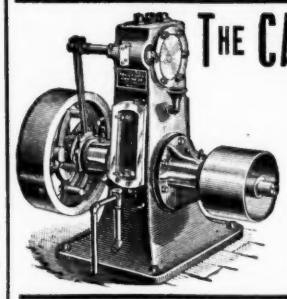

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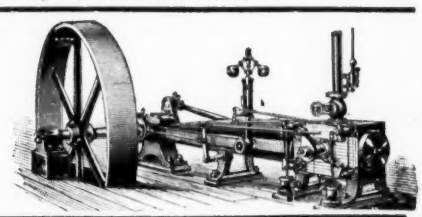

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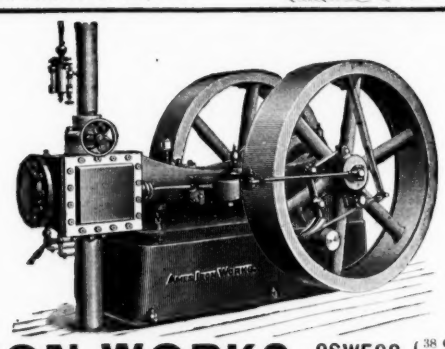

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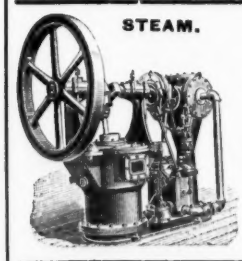

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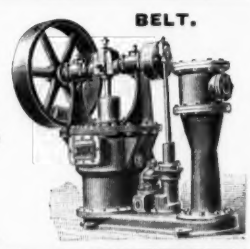

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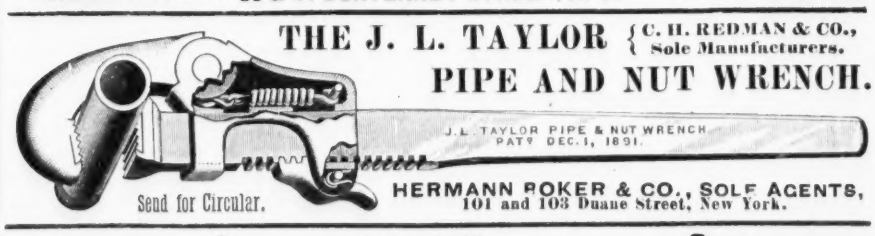

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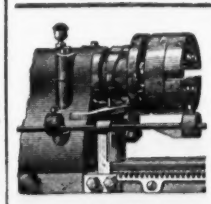

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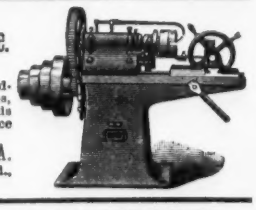

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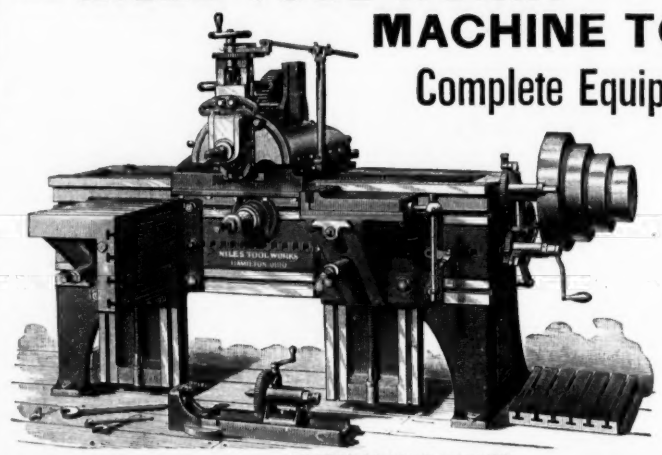

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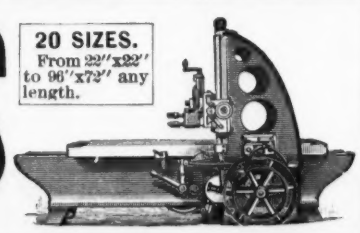

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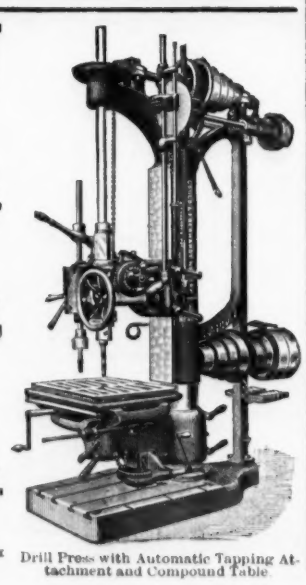

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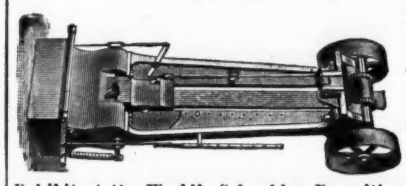

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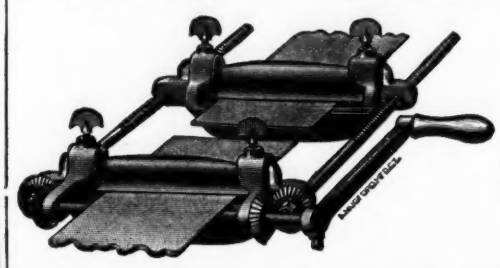

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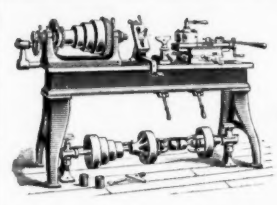

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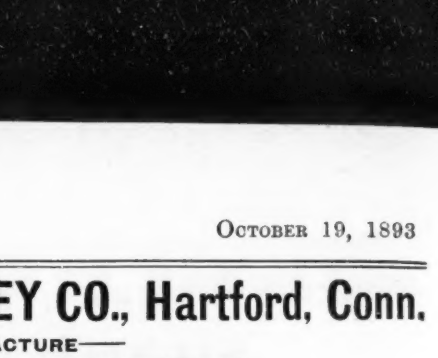

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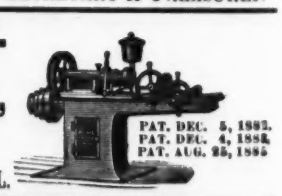

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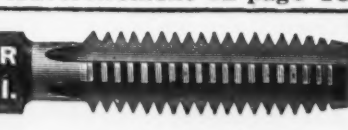

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